Iron AND Steel ENGINEER

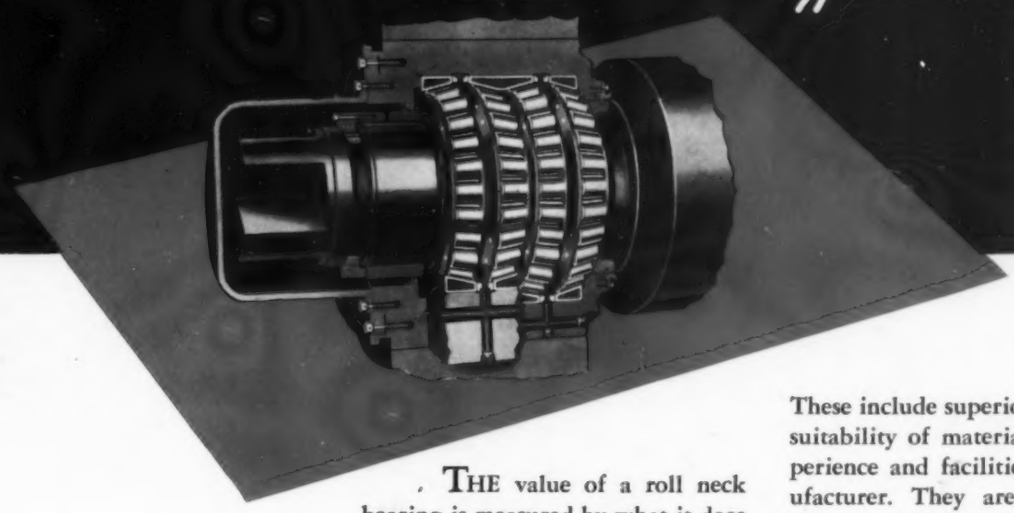
ENGINEERING SERVICE
TO THE IRON AND STEEL
INDUSTRY SINCE 1907

1010 EMPIRE BUILDING — November, 1943 — PITTSBURGH, PA.

DEC 10 DETROIT

IT'S THE INTANGIBLES THAT COUNT

in Roll Neck Bearings



THE value of a roll neck bearing is measured by what it does —not what it looks like. You can't gauge the potential life of a bearing by its appearance. It's the intangibles that count — the things you can't see; inherent qualities essential to performance, endurance and economy.

These include superiority of design; suitability of material; and the experience and facilities of the manufacturer. They are the qualities that give Timken Roll Neck Bearings the greatest life expectancy (measured in tonnage rolled) and the lowest bearing cost per ton rolled; they are the qualities that make Timken Roll Neck Bearings your best buy. The Timken Roller Bearing Company, Canton, Ohio.

Beat post-war competition to the punch; step up the performance of your equipment by redesigning to include more Timken Bearings.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Iron & Steel Daily News

OFFICIAL PAPER FOR THE 1943 CONFERENCE — PUBLISHED BY ASSOCIATION OF IRON & STEEL ENGINEERS

VOL. IV No. 4 — PITTSBURGH, PENNSYLVANIA — OCTOBER 1, 1943

"ACCIDENTS STILL ROBBING US OF VITAL WAR PRODUCTION HOURS"

"Remedy for This Situation Lies in Concerted Action," Says Irvin

annual meeting of the Association, W. A. Irvin, e board of trustees, National Safety Council, re- lopment of the safety movement in this country, olea to mobilize all our forces against this foe. center came a total of 2,000 to attend this suc- rence. Practical discussion of production prob- e entire technical program.

"It is in the development of such a movement that the National Safety Council is now engaged," Irvin stated. "This undertaking had its inception two years ago when the President of the United States called upon the Council to mobilize the safety forces of the nation in a concerted attack on accidents that were seriously impeding war production. The serious extent to which this situation was affecting the national interest was obvious from the very enormity of the accident toll."

Mr. Irvin recounted the subsequent steps taken in raising a fund by voluntary subscription, to finance the new programs. The cooperation of the ess, radio, magazines and mo- n pictures was stressed. ety education was dissem- ed through more than 100 n-wide volunteer organiz- , and safety work was l into the nation's armed s. Programs of home and afety and off-the-job ere intensified.

s of the program thus own by comparing the f 1943 with the cor- period of 1941:

cident death toll is The rising tide of kers through on- nts has been halt- a 17% increase worked. Traffic n 41% largely traffic restric- part to public deaths, oth- down 9%. n accidents

us," said the right ur truly lem, and effort. behind and safety programs in companies, in our commun- ities, in our states and in our country with vigor and deter-

Human Engineering A Necessary Viewpoint

By E. E. MOORE

Improvement in the lot of mankind has been the result primarily of scientific disc- ies and engineeri- ments. The ende-

Safety Comes B-

The Cutler-Hammer Crane Safety Limit Stop

THE importance of accident prevention in the steel industry where such a vital role is being played in the nation's war effort requires no elaboration. Thus it is only natural that such a proven protection to life and property as the Cutler-Hammer Crane Safety Limit Stop should be a "must" in many equipment programs today. This device offers *complete* protection at a point where nothing less than *complete* protection is worth consideration. Not only is its design all-comprehensive in meeting practical operating requirements but the known dependability of Cutler-Hammer manufacture assures its reliable operation regardless of dirt, rain, snow, ice or any other adverse conditions. In enclosure, supports, insulation, bearings and mechanism alike, you will find tremendous reserves, adequate to the serious responsibility involved. Low headroom and operating lever mountable in any of four quadrants fit it for any installation. Write or wire for complete information . . . CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

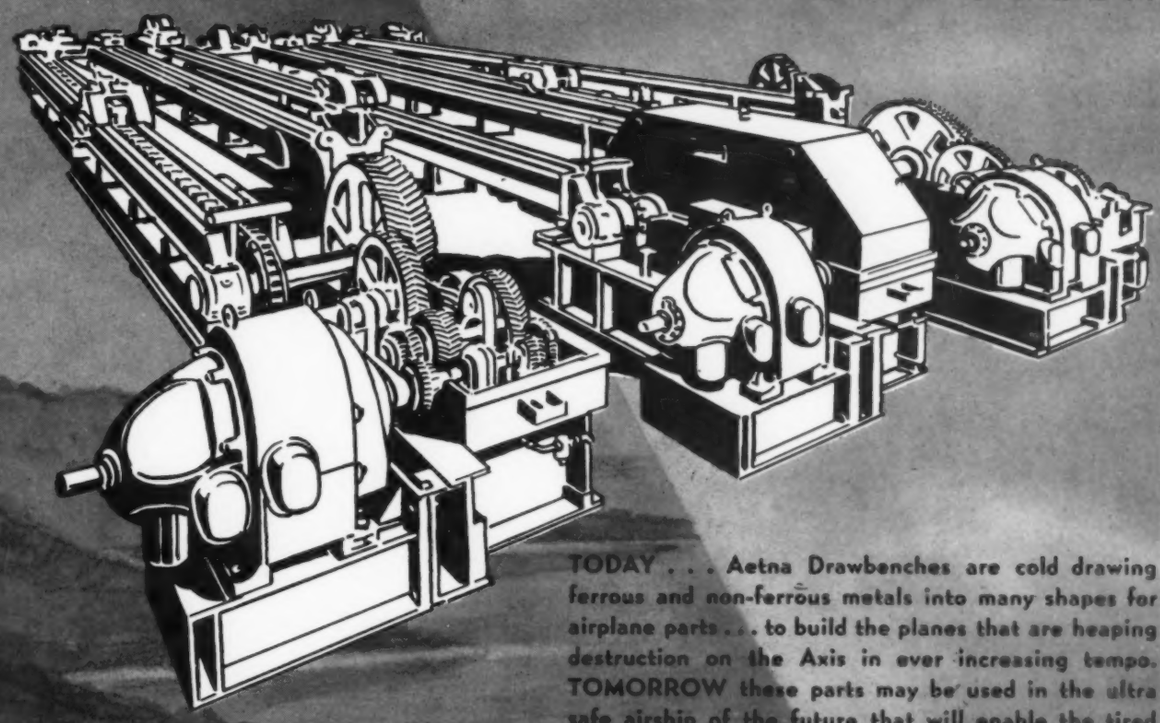
Milwaukee Plants

CUTLER-HAMMER
MOTOR CONTROL
C-H

AETNA LOOKS TO FUTURE HORIZONS

AETNA DRAWBENCHES

FOR EVERY COLD DRAWING PROBLEM



TODAY . . . Aetna Drawbenches are cold drawing ferrous and non-ferrous metals into many shapes for airplane parts . . . to build the planes that are heaping destruction on the Axis in ever increasing tempo. TOMORROW these parts may be used in the ultra safe airship of the future that will enable the tired businessman to hop into the wilds for a weekend of fishing or hunting . . . this will be just one of the features of a new world that will emerge from the present conflict.

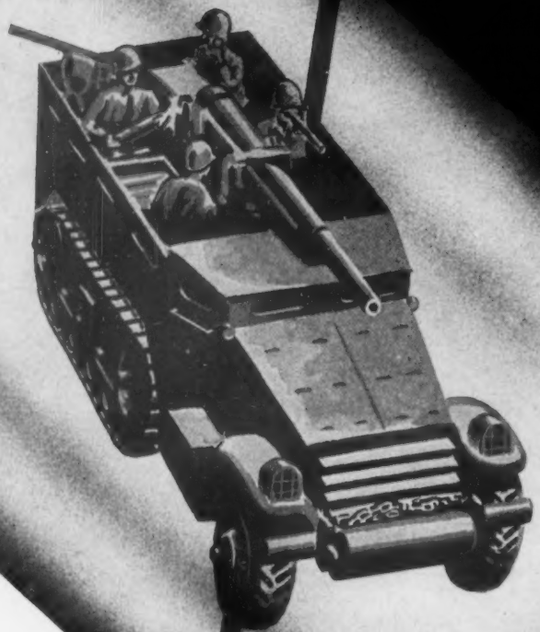
AETNA·STANDARD

ARMY E NAVY

DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

BETTER FINISH INCREASED TONNAGE



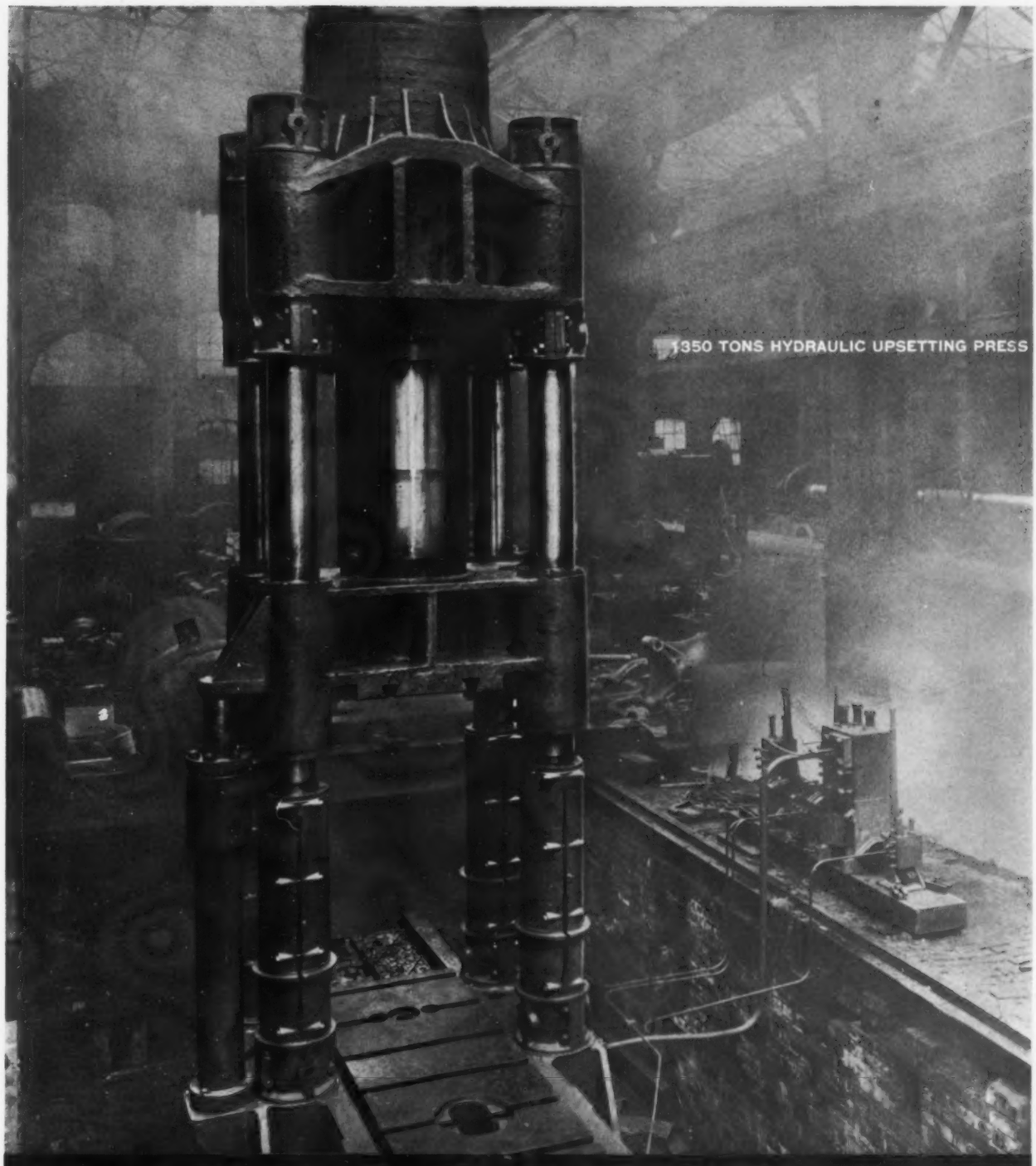
Let Lewis Rolls help answer the call for more and more production. Lewis research and experience in roll fabrication have contributed to the establishment of many production records.

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PA.

LEWIS ROLLS

Also manufacturers of **ROLLING MILL MACHINERY** for the iron, steel and non-ferrous industries

★ ★ ★ ★ FOR VICTORY BUY U. S. WAR BONDS AND STAMPS ★ ★ ★ ★

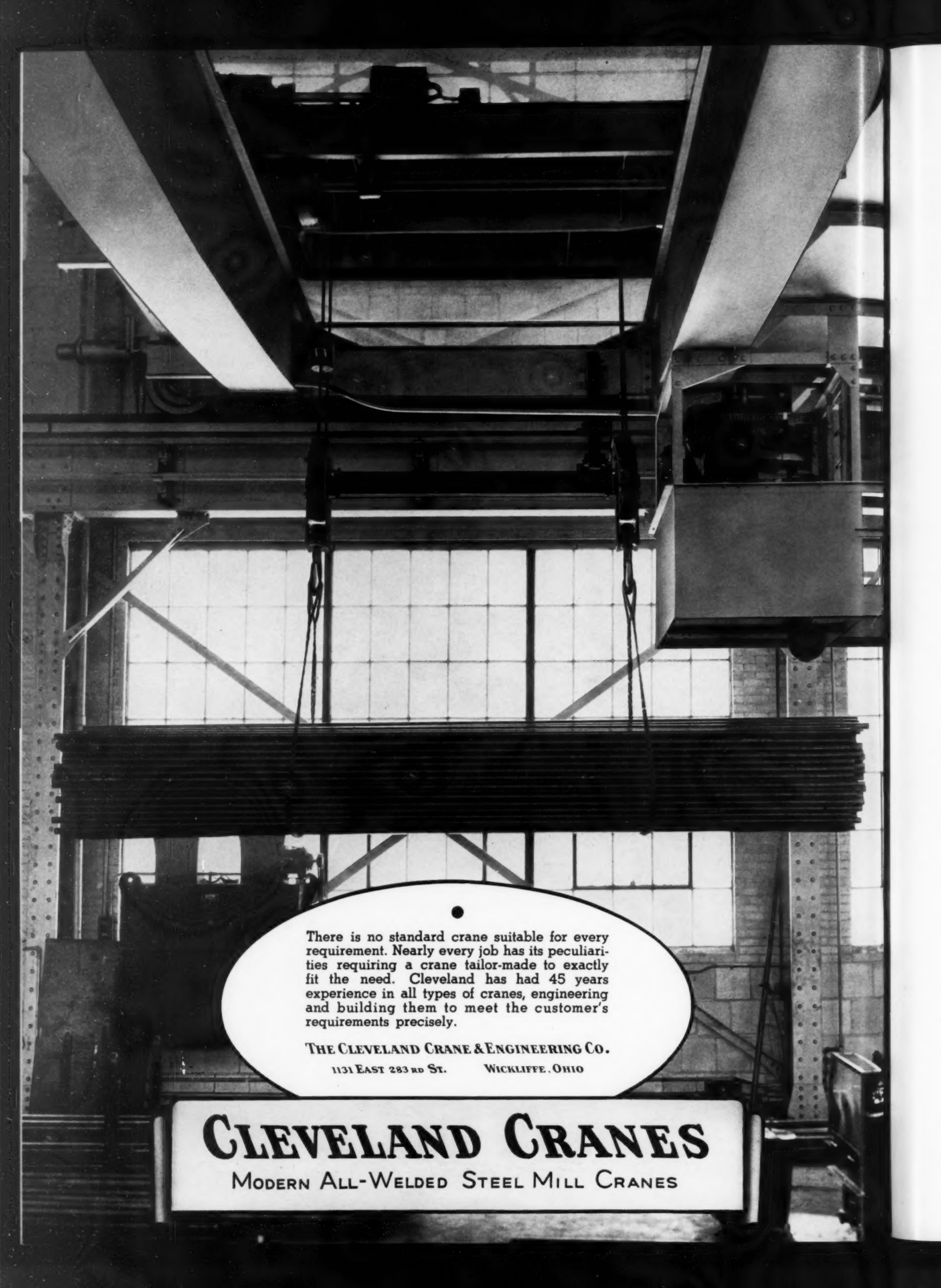


HYDROPRESS · INC.

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS
PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE • NEW YORK • N. Y


There is no standard crane suitable for every requirement. Nearly every job has its peculiarities requiring a crane tailor-made to exactly fit the need. Cleveland has had 45 years experience in all types of cranes, engineering and building them to meet the customer's requirements precisely.
THE CLEVELAND CRANE & ENGINEERING CO.
1131 EAST 283 RD ST. WICKLIFFE, OHIO
CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

IN spite of a loss of 110,000 tons of steel caused by Coal Strike IV, October brought a new production record of 7,786,359 tons of ingots and steel for castings, exceeding the peak set last March by over 100,000 tons. Going into the total were a great many individual company production records.

▲

SPEAKING of the coal strike — or rather, its settlement — we haven't yet read in the papers as to who really won. About the most outstanding result seems to be that requests from other industries for higher wages will soon outdistance the repetitious requests for mamma to put away her shootin' iron.

▲

FOLLOWING its original request that some alloy steels be switched from the open hearth to the expanded electric furnace capacity to make room for carbon steel in the open hearths, WPB has issued orders that seven specific types of alloys, classified by end use, must be made in electric furnaces. The types are: all airborne aircraft steel where aircraft quality is specified; all airborne aircraft tubing; all armor-piercing shot body and cap steel, 20 mm and larger; all steel for integral parts of small arm rifles and machine guns up to 60 caliber, excluding mounts and tripods; all steel for integral parts of guns, cannons, rifles and howitzers, 20 mm and larger, excluding mounts and carriages; all bearing steel, including carburized grades; all gear steel, excluding gears made from plate.

▲

THE Electric Metal Makers Guild, Inc., will hold a one day sectional meeting December 4th in Chicago. As in the case of previous sectional meetings, non-member melting foremen, melters and furnace helpers are invited.

▲

RELATIVE to our item last month concerning high school yearbook predictions, a reader sends in a photograph — bald as a billiard ball — to prove that he lived up to his prediction, which was that his forehead was most likely to recede. What we would like to know, however, was who sent in the photograph in a convict suit, and was it intended as proof of a yearbook prediction.

PUBLISHED by the Salvage Division of WPB, a "Salvage Manual for Industry" offers information on how to set up a salvage campaign in the plant, how to collect, segregate, prepare and classify metallic scrap, etc. Information on salvage practices for oils, greases, paints, and other non-metallic waste is also given. The book, 243 pages and paperbound, may be obtained from E. F. Mulligan, Salvage Division, WPB, 1100 H Street, N. W., Washington, D. C., or from the Superintendent of Documents.

▲

REMEMBER when, during an average lifetime, there were lots of presidents, heavy-weight champs, etc.?

▲

ANOTHER prediction for post-war activities states that repair and maintenance expenditures will break all records — also that the value of new construction, at 1943 costs, will duplicate the 1926-27 peacetime high. In physical volume, this construction would be 64 per cent above 1935-39, but 28 per cent lower than 1925-29, due to 30-40 per cent higher costs at present.

▲

CONSTRUCTION of electrolytic tinning lines has surpassed applications of their product, with the result that units already completed are not operating at full capacity. The construction program is nearly completed, with 26 lines finished and two more which should be finished by the end of the year. On the other hand, application of the .5 lb coating has been limited to non-processed products with little or no corrosive characteristics. In isolated instances, heavier coatings have widened the application somewhat, and additional uses will no doubt be set up.

▲

PROGRESS in our production war may be noted by marked easement here and there in supplies, orders, etc. Chromium, molybdenum, vanadium and tungsten are loosening up, as is merchant iron, aluminum, etc. Cancellation of steel orders is increasing at a rate which may lead to more steel for civilian uses. This doesn't mean the war is won, of course, but straws don't go against the wind.

▲

WITH the Army and Navy already reporting more than $150,000,000 on hand in surplus war materials, we believe that the greatest post-war opportunity lies in the field of the "Army-Navy" stores so prevalent after the last war.

▲

FROM various sources come recommendations that the Federal Government accumulate, in the immediate post-war period, one-year supply stockpiles of all metals used in carrying on war. This move, in addition to the protection offered in any future emergency, would free the post-war market of excess materials and assure fresh production demands.

Look

The best test of any soaking pit is what it does in action. For 17 years the one-way-fired pits built by Surface Combustion have been doing a job in American steel mills. Witness the many pits bought by one big steel company, shown on the opposite page. More and more as engineers have seen these pits at work in their own mills they have come to rely upon them exclusively.

See these pits in action. Talk to the men who run them. Surface Combustion one-way-fired soaking pits operate on any commercial fuel. They're built to take punishment and to give service.

Simplest Construction
Greatest Capacity
Most Efficient Firing
Best Heat Distribution
Lowest Maintenance

SURFACE COMBUSTION • TOLEDO, OHIO

SC SURFACE

MANUFACTURERS OF SC INDUSTRIAL FURNACES •

at the Facts!

The best testimonial that a steel mill can give a manufacturer is to come back time and time again for more of the same pits.

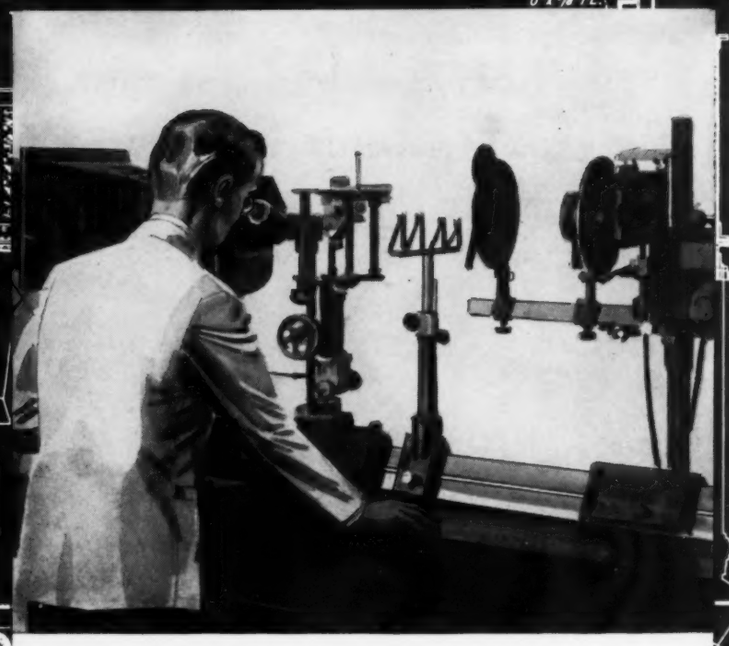
HERE'S THE RECORD OF ONE OF AMERICA'S BIG STEEL COMPANIES
DATE ORDERED
LOCAL PLANT
NUMBER OF SURFACE COMBUSTION PITS ORDERED
DEC. 1927 — PLANT A — 5 PITS
MAR. 1929 — PLANT B — 4 PITS
MAR. 1929 — PLANT C — 7 PITS
NOV. 1931 — PLANT D — 4 PITS
DEC. 1936 — PLANT A — 4 PITS
NOV. 1940 — PLANT B — 5 PITS
JUNE 1942 — PLANT E — 24 PITS
JAN. 1943 — PLANT A — 3 PITS
TOTAL 56 PITS
SC Gas and Oil Fired Equipment For Every Industrial Need: FORGING, NORMALIZING, ANNEALING, HARDENING, DRAWING, HEATING, CARBURIZING, NITRIDING, SPECIAL ATMOSPHERES. FOR DRY BLAST USE SC KATHABAR MOISTURE CONTROL SYSTEMS.

COMBUSTION

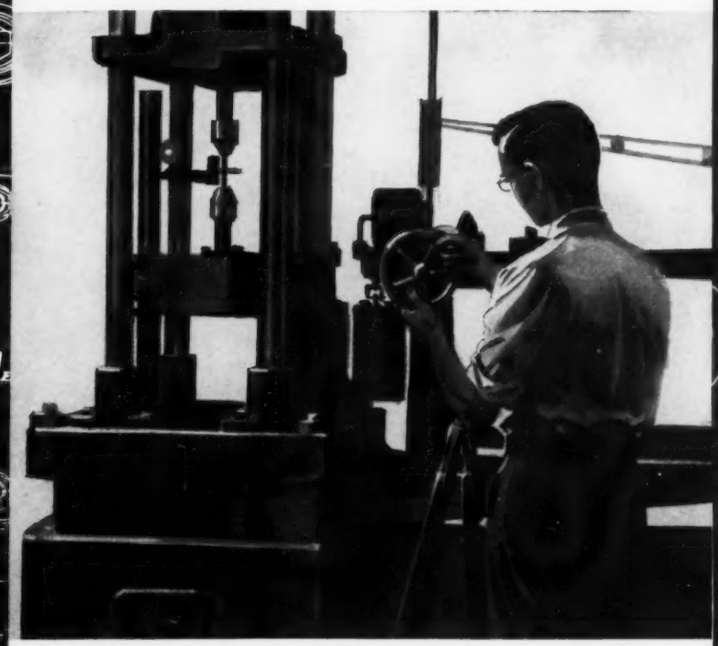
JANITROL GAS-FIRED SPACE HEATING EQUIPMENT • KATHABAR SYSTEMS FOR DRY BLAST

To Manufacturing Executives *Everywhere...*

ANNOUNCING



Metallurgical studies form an important part of the investigations of the behavior of fasteners under various service conditions.



A broad and thorough program of technical exploration, sponsored by the Institute, employs the facilities of outstanding technological laboratories.

. . . a program to help you use

FASTENERS

(Bolts, Nuts, Rivets, Screws)

More Efficiently

More Economically

More Effectively

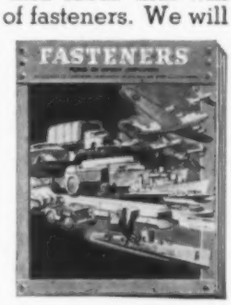
Sponsored by the American Institute of Bolt, Nut and Rivet Manufacturers

The basic dependability of Fasteners has led to their use wherever reliable connections are needed. Keeping abreast of engineering developments, makers of these products have constantly improved and refined the various items in their lines, making use of advanced metallurgical and precision manufacturing processes. As a result, higher strengths, closer tolerances, better finishes, etc. are available to engineers and manufacturers using bolts, nuts, rivets and screws.

To acquaint you with these advances, and to help you make fullest use of the products of the Fasteners industry, the Institute is sponsoring an informative campaign. New engineering data, application information and product developments will be spotlighted in this activity.

FACTUAL DATA BULLETIN

One of the primary features of this activity will be a bulletin "FASTENERS" to be issued at regular intervals. It will contain authoritative and useful data and ideas that will help you make best use of fasteners. We will be glad to send it to you regularly at no cost if you are interested in learning more about the ever widening applications and possibilities of bolts, nuts, rivets, screws, and other headed and threaded products.



American Institute of Bolt, Nut and Rivet Manufacturers

1550 Hanna Building · Cleveland 15, Ohio

This OPERATOR HAS *MORE* THAN TEN PAIRS OF HANDS

The BILLETEER

- INCREASES clean billet tonnage. One operator can do the work of from 10 to 25 hand chippers.
- ELIMINATES the overhead cost of hiring gang after gang of men where the "toughest job in the mill" is still creating constant labor turnover.
- SAVES steel. Billets on which the amount of chipping required would be prohibitive by hand chipping can be salvaged at a reasonable cost. This justifies reclaiming bad heats.

With tonnage and more tonnage so vital now, the mechanization of this one last drag on mill schedules is good business.

The Bonnot-Lentz Billeteer was thoroughly proved and the bugs removed long before war tonnage was essential to our national emergency.

For facts and figures on Billeteer savings, our best references are those plants with several units in their production lines. Write us.

ONNOT-PRODUCTS
ENGINEERED
FOR IMPROVED
PRODUCTION

75% OF OUR ORDERS ARE FROM PLANTS WHICH HAVE THEIR OWN FIGURES ON BILLETEER SAVINGS!

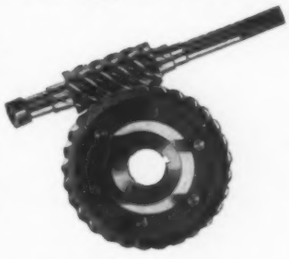
THE BONNOT COMPANY, CANTON, OHIO

BONNOT

ENGINEERED FOR IMPROVED PRODUCTION

Clevelands . . . on Modern Soaking Pits and Blooming Mills

With your urgent need to make every production minute count, you appreciate more than ever the quiet, dependable performance of the sturdy Cleveland Units that are driving your present Soaking Pit and Blooming Mill equipment. Doubtless you are specifying Clevelands for new machines as well.



For 25 years you have been installing Cleveland Worm Gear Speed Reducers successfully on your toughest jobs, knowing they will take punishment in their stride and come up smiling. Clevelands stand the gaff—require but nominal maintenance—with no parts replacements for years on end.

The Cleveland Worm & Gear Company • 3278 East 80th Street, Cleveland, Ohio

Affiliate: The Farval Corporation, Centralized Systems of Lubrication

In Canada: PEACOCK BROTHERS LIMITED

CLEVELAND WORM GEAR *Speed Reducers*

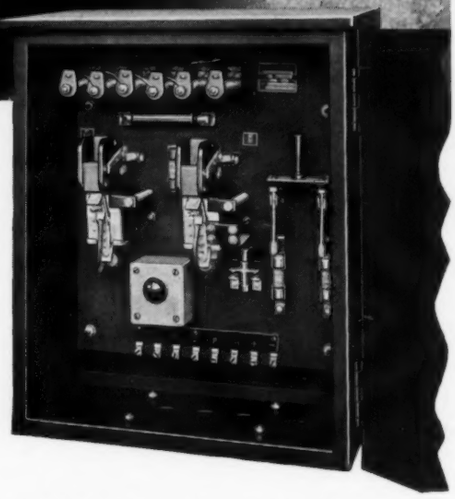
EC&M Spring-Loaded Magnetic Contactors "met the situation"

Official U. S. Navy photograph

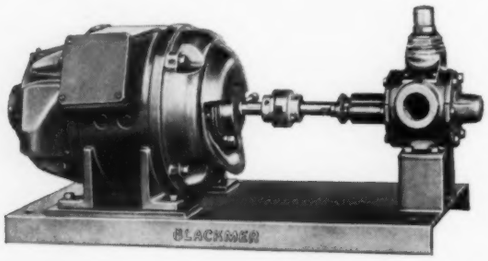
THE Government needed magnetic starters for auxiliary pumps on mine-sweepers — starters to withstand the rolling and pitching of these small craft on heavy seas — starters so designed that accidental closing could not happen under these conditions.

EC&M had a commercially proven, spring-loaded contactor of proper size — one which was held in the "open position" by a spring. The need was urgent — EC&M quickly designed starters to "meet the situation."

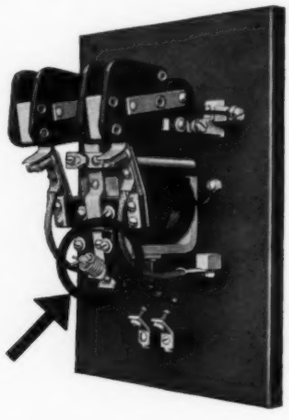
On many phases of the war effort, EC&M Contactor Control is giving a splendid account of itself on vital projects of extreme interest. Some day, perhaps, the story can be told.



Typical EC&M D-c Starter with single-pole, spring-loaded contactors, front-connected resistors and drip-proof cabinet.



Blackmer pump unit of the type used for naval auxiliaries.



Showing location of spring on EC&M 50-ampere Contactor of double-pole design.

THE ELECTRIC CONTROLLER & MFG. CO.
2700 EAST 79th STREET ★ CLEVELAND 4, OHIO

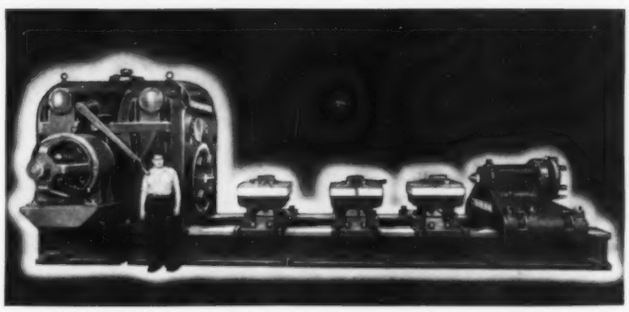
CONTINENTAL EQUIPMENT

for

NATIONAL STEEL COMPANY

Volta Redonda, Brazil

2—No. 5 Continental Roll Lathes for Brazil



The following Continental equipment was furnished to the National Steel Company in Brazil.

Complete Tie Plate and Splice Bar departments including 750 ton tie plate punches, 450 ton splice bar punches and conveyors, pushers and quenching tank.

Roll shop equipment in this installation included 2—No. 5, 1—No. 3, and 2—No. 2 Continental Roll Lathes.

For custom rolls, Rolling Mill equipment, Carbon and Alloy Steel Castings and special machinery of many types, consult Continental.

CONTINENTAL ROLL & STEEL FOUNDRY COMPANY

CHICAGO · PITTSBURGH

WEAN

OVERHUNG COIL HOLDER

HEAVY PLATE LEVELERS

HI-SPEED SHEET AND TIN MILL SHEAR LINES

ELECTROLYTIC & BONDERIZING TIN PLATE EQUIPMENT

WILSON TUBE ANNEALING FURNACES

WEAN VACUUM CUP SHEET AND PLATE LIFTERS

CONTINUOUS STRIP PICKLING, SLITTING, SIDE TRIMMING, AND RECOILING LINES

WIRE AND FENCE MACHINERY

The WEAN

ENGINEERING CO., Inc. - - WARREN, OHIO

Subsidiary Company
The Broden Construction Company
Cleveland, Ohio

Associated Companies

LEE WILSON ENGINEERING CO.
CLEVELAND, OHIO

THE McKAY MACHINE CO.
YOUNGSTOWN, OHIO

THE WELLMAN SMITH OWEN ENGR. CORP., LTD.
LONDON, ENGLAND

FLINN & DREFFEIN CO.
CHICAGO, ILL.

THE HALDEN MACHINE CO.
THOMASTON, CONN.

THE WEAN ENGINEERING CO. OF CANADA, LTD.
HAMILTON, ONT.

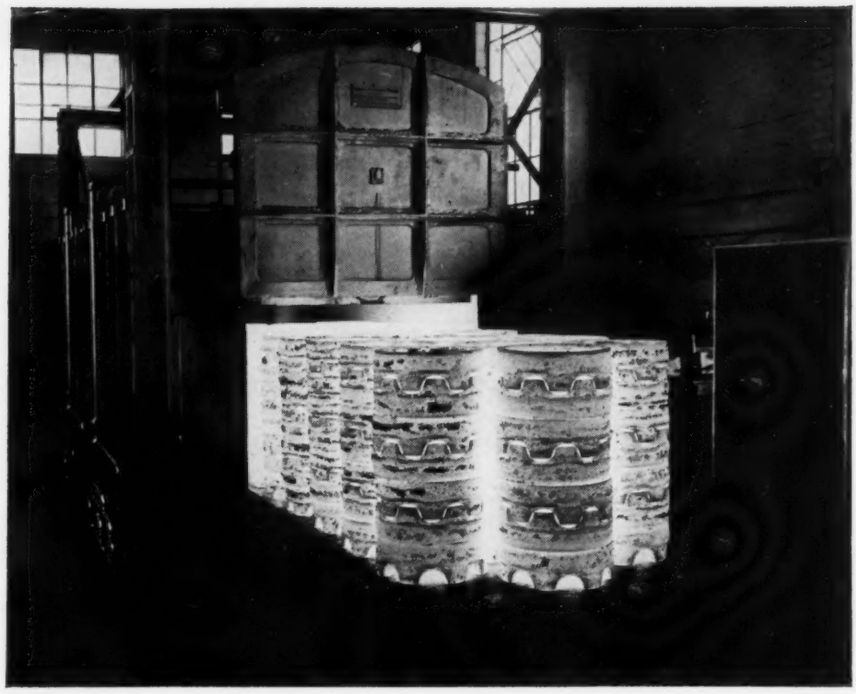
SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

A
RUGGED
B'AR
GUIDE
THAT
WON'T
LET
YOU
DOWN

TRANTINYL
BAR MILL GUIDE

Youngstown Alloy Casting Corporation

YOUNGSTOWN, OHIO



One hundred and fifty rough-forged crank cases for warplane engines, just after being normalized on one of the Massachusetts Steel Treating Co.'s (Worcester, Mass.) National gas-fired furnaces. Temperature limits for all aircraft parts are rigid, and to assure the most dependable control for such vital war work, the temperature is regulated by the Micromax Electric Control Pyrometers shown below.

"TAKE NO CHANCES" Policy Leads Heat-Treat Firm to Micromax Pyrometers

Control panel for two two-zone Mass. S. T. Co. furnaces; the Micromax Pyrometers at the rear regulate furnace shown in upper photo; others regulate a smaller furnace. In each case there's a Micromax for the front zone and one for the rear. Each Micromax throttles gas fuel *in strict proportion* to the needs of its end of the furnace, and the result is a control so close that you'd usually need a magnifying-glass to see the "wiggles" in the temperature record.

"Never take a chance with a customer's goods — that's our policy," say the owners of the Massachusetts Steel Treating Co., "and that's why we use Micromax Control Pyrometers on our furnaces. If a customer says 'Heat these forgings to 1700' and we use Micromax Controllers to regulate the heat, we know and our customer knows that we took no chances on that temperature equipment. Nobody even questions it — Micromax is standard for best temperature control."

Several very specific features back up this opinion of Micromax. It is so fully automatic that it runs for days at a time without being touched. It standardizes itself; holds several weeks' supply of ink and chart paper; signals when it needs either ink, chart or dry cells. And it's mechanically more like a machine-tool than an instrument; it has cut gears; thick shafts; sturdy frame castings. The assembly is expertly well-fitted and snug. The entire Pyrometer is designed to take full responsibility for important temperatures, and handle them with complete satisfaction.

If you have a pyrometer problem, an L&N engineer will gladly help solve it. If a catalog meets your present needs, ask for either N-33A on Micromax for Thermocouples, or N-33B, Micromax for Rayotubes.

A Slogan For Every American

Jrl Ad N-33-620(7)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

REPORTING *on the use of*

Linde Methods

in mass production..

STEELMAKING—If You Use Steel, You Should Know More About These Linde Methods That Help Produce Better Steel Faster . . .

In this picture, an acetylene generating plant at a steel mill is being supplied with Union Carbide. Large-capacity generator plants like this are a development of The Linde Air Products Company. The calcium carbide is automatically processed to form acetylene gas as needed. The acetylene is distributed at a predetermined pressure throughout the mill in pipe lines to operating stations where it is used.

Because the oxy-acetylene flame is one of today's most efficient mass-production tools, steel mills require such large quantities of acetylene that much of it is made in generators right at the mills.

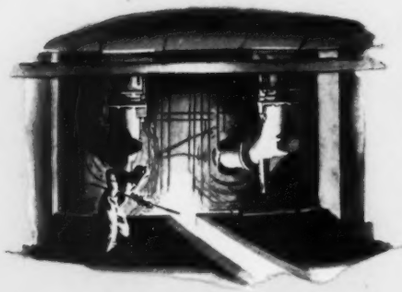
Shown in the following pages are some of the ways in which the production of steel is speeded by using the oxy-acetylene flame techniques and equipment developed by the Linde organization.

Similar Linde methods are saving time and materials in shipyards . . . in ordnance plants . . . in fact, in essential plants of every kind where metals are cut, formed, joined, or treated. They are methods that suggest over and over again the importance of keeping up to date on everything that has to do with the oxy-acetylene processes.

Through the Complete Cycle of Steel Production . . .

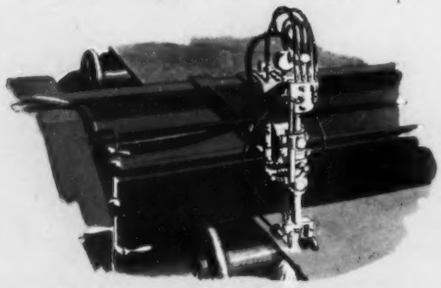
Linde Methods save time and materials

The engineering facilities of The Linde Air Products Company have been developed through many years to aid industry in adapting such methods as are illustrated here. These Linde facilities are importantly employed in helping to meet the specialized mass-production needs of today. When the time comes to switch your production facilities to work on automobiles . . . or tractors . . . or home appliances . . . or other things that all of us want . . . Linde's enlarged experience will be available to help speed the conversion.

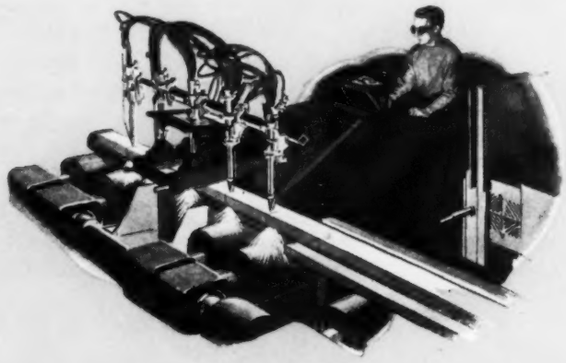


FURNACE-TAPPING—By use of the oxygen lance to clear the tap hole, the opening is quickly made for molten iron to pour from the blast furnace. The oxygen lance also is used to tap open-hearth furnaces, and for heavy work like cracking "skulls" and piercing thick sections of steel.

DESEAMING—Where mechanized conditioning of steel is not feasible, or for use in secondary conditioning, oxy-acetylene deseaming with Linde's manually operated scarfing equipment is quick, economical, and effective. Other types of blowpipes are widely used for rivet cutting, for removing defects in castings, for other forms of gouging, and for scrap-cutting.



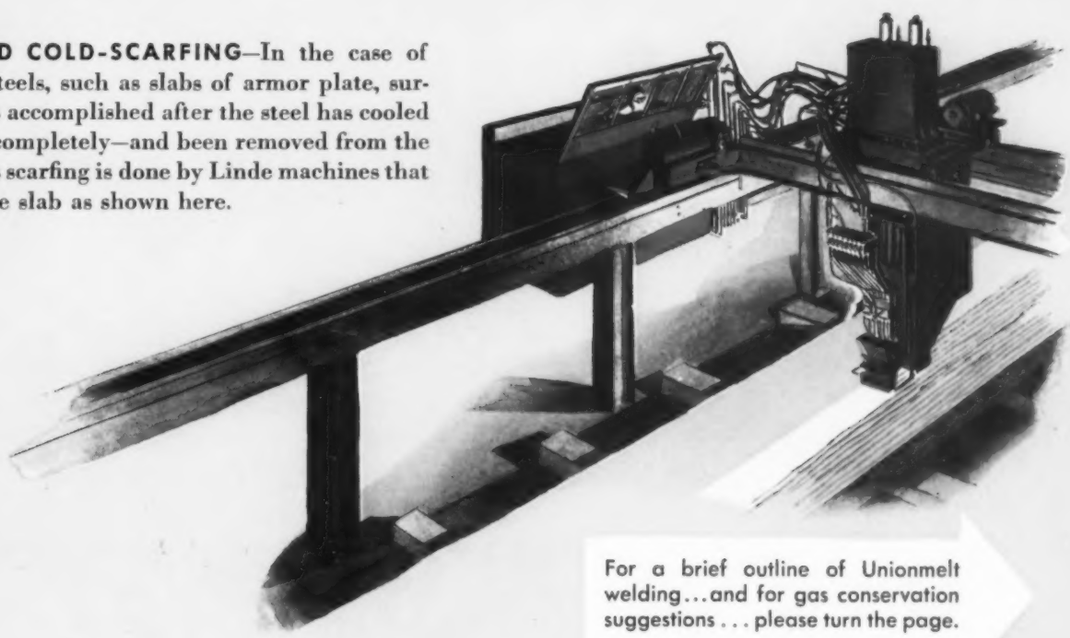
MECHANIZED PLATE-CUTTING—Much of the steel plate produced must be cut to the correct size before it is shipped for further fabrication. Batteries of small oxy-acetylene cutting machines mounted on gantry cranes are used to speed this work . . . cutting large, heavy plates into as many pieces as required, in one pass.



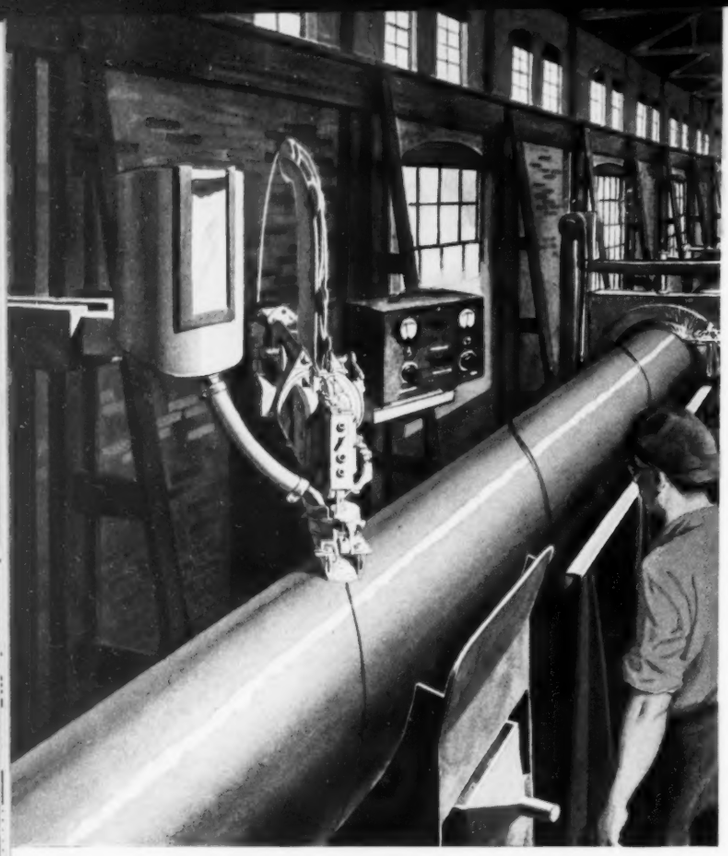
MECHANIZED BILLET-CUTTING — Flame-cutting machines developed by Linde are used in the production line to cut billets, bars, and rounds to length . . . several pieces at a time . . . quickly . . . economically . . . with no need for the massive, power-consuming machines that otherwise would be necessary.

MECHANIZED FLAME-SCARFING — The removal of surface defects from semifinished steel . . . to produce a higher yield of quality steel . . . is accomplished without interruption of production through use of Linde-developed equipment like the oxy-acetylene scarfing machine shown here installed in the production line. As billets or slabs—ranging in cross section from 5 in. by 5 in. to 14 in. by 32 in.—roll through, the mechanized batteries of oxy-acetylene blowpipes literally "skin" faulty surfaces from the hot steel.

MECHANIZED COLD-SCARFING—In the case of some special steels, such as slabs of armor plate, surface removal is accomplished after the steel has cooled —partially or completely—and been removed from the roll table. This scarfing is done by Linde machines that move along the slab as shown here.



For a brief outline of Unionmelt welding... and for gas conservation suggestions . . . please turn the page.



Unionmelt Welding in mass fabrication

Unionmelt welding is a unique, automatic electric process that joins steel of any commercial thickness at high speeds. Welds are uniform because, once the controls are set by the operator, the work progresses automatically. The weld is made without flash, glare, or sparks.

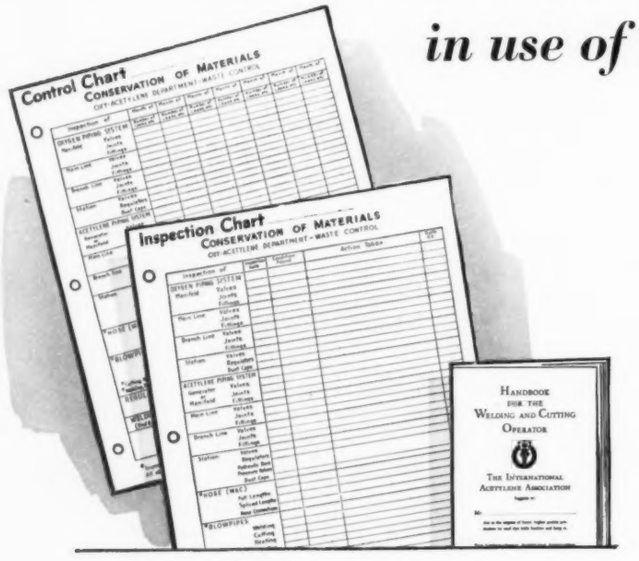
Shown here, Unionmelt welding is being used to fabricate spiral pipe. An oxy-acetylene machine is cutting the finished pipe to length.

Unionmelt welding also is an efficient mass-production tool in the fabrication of ships, combat vehicles, locomotives, pressure vessels, and many other types of heavy equipment.

The wide use of the Unionmelt process has been facilitated by Linde's flame-cutting equipment, which quickly trims steel to size and shape, ready for welding.

A Planned Program to Save Materials

in use of the Oxy-Acetylene Process



The operations described in the preceding pages suggest the importance of using oxygen and acetylene productively . . . without waste.

Effective use of oxygen and acetylene requires a planned program—including appointment of inspectors responsible for regular testing for leaks, for making prompt repairs, and for keeping a record to give management a continuing picture of results. It must strike at the many small points where the greatest overall losses usually occur.

The charts shown here will help to do this in your plant or shop. The "Handbook" will help your operators to understand and avoid wasteful practices. Copies can be obtained without charge from any Linde sales office.

MARITIME "M" AWARD FOR OUTSTANDING PRODUCTION ACHIEVEMENT

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

The words "Linde," "Union," and "Unionmelt" are trade-marks.

BUY UNITED STATES WAR BONDS AND STAMPS

VARNISHED CAMBRIC INSULATION

is one answer to the rubber shortage

Single conductor. Braid covering.
Three conductor. Lead sheath.
Switchboard wire. Flameproof braid.
Interlocked armor for indoor use.
Non-metallic sheath to protect lead.
Shipboard cable. Metal braid —AIEE type.
Okobestos switchboard wire.
Okobestos power cable.

This booklet—OK-1013A—can help solve your wiring problems.

A recent WPB ruling has forbidden the use of natural rubber in the manufacture of electrical wire and cables for most commercial purposes. To help satisfy *your* wiring needs, why not consider the use of Varnished Cambric insulated cables?

Okonite Varnished Cambric cables are *stable, long-lived* and *easy to handle.* Resistant to heat, oil and ozone, these cables can be used in power circuits for either high or low voltages—for switchboard and control wire—for generator or motor leads—and for many other applications. Okonite V. C. wires and cables are made in either single or multi-conductor construction for all voltages up to 28,000 volts.

Insulated with oil-impregnated cloth, V. C. cables require only a minimum of critical materials. In addition, the higher permissible operating temperature of this type insulation conserves copper by allowing heavier current loadings for a given conductor size.

Okonite Varnished Cambric wires and cables can be supplied in a variety of suitable coverings—lead sheath, wire or metallic tape armor, synthetic jacket, asbestos, or flame-retardant cotton braid. Bulletin OK-1013A contains 36 pages of information on their selection, capacity and installation. Write today for your copy. The Okonite Company . . . Passaic, New Jersey.

VARNISHED CAMBRIC INSULATION IS NOT JUST ANOTHER WARTIME SUBSTITUTE

— yet it saves Copper, Tin and Rubber

Varnished Cambric insulated wires and cables were not developed as a substitute to meet a wartime emergency. Okonite has been a leading manufacturer of a complete line of Varnished Cambric wires and cables since 1912. For over 30 years V. C. cables have proved to be exceptionally reliable and long-lived.

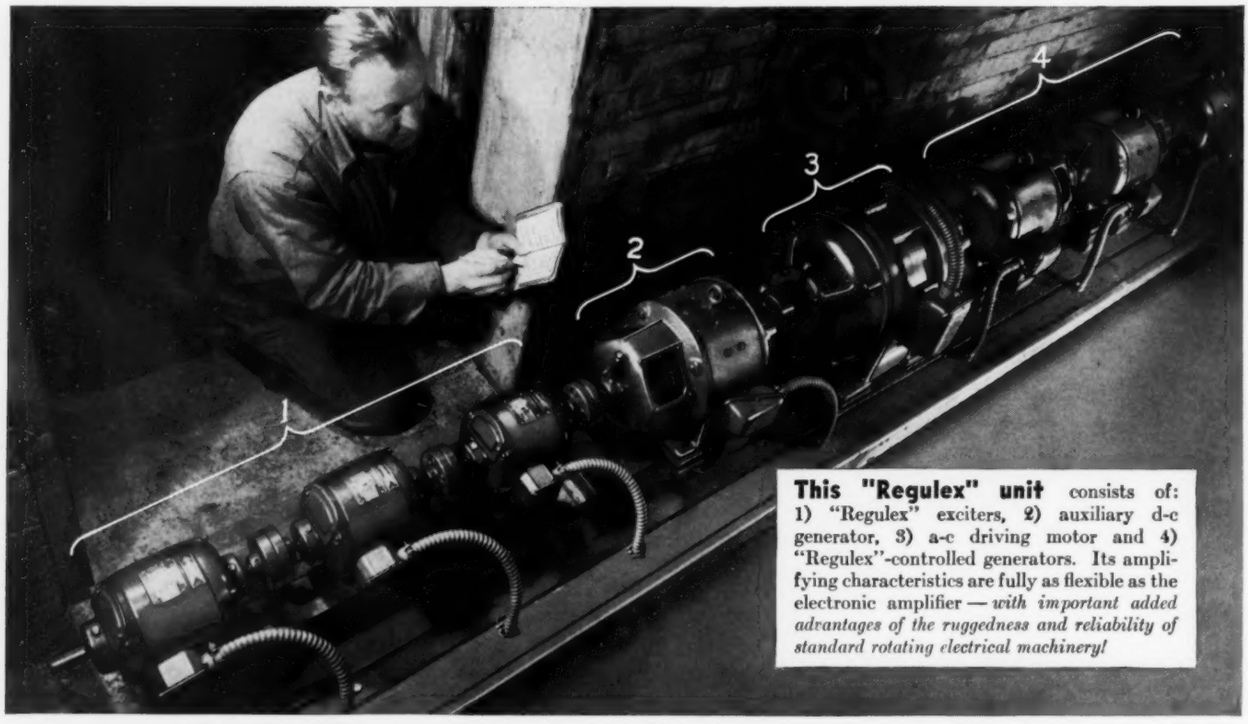
OKONITE

INSULATED WIRES AND CABLES

3417

GET MORE "HEATS" per day with the revolutionary new Allis-Chalmers electric furnace control with the "Regulex" exciter.

☛ This unit produces electrode speeds proportional to deviation of controlled quantity from desired value, compensates rapidly for sudden current fluctuations. ☛ With no large resistance in circuit—maximum rated speed of the electrode motors is available for quick automatic correction after a "cave-in". ☛ Heavy starting surges, caused by throwing 250 volt d-c motor across-the-line, are eliminated by variable voltage control. ☛ Arc furnace power and control are independent of d-c shop supply interruptions when desired. ☛ Regenerative braking action of the "Regulex" exciter unit stops electrode motors fast. Maintenance is slashed.



This "Regulex" unit consists of: 1) "Regulex" exciters, 2) auxiliary d-c generator, 3) a-c driving motor and 4) "Regulex"-controlled generators. Its amplifying characteristics are fully as flexible as the electronic amplifier — *with important added advantages of the ruggedness and reliability of standard rotating electrical machinery!*

INDIVIDUAL "Regulex" units are quick-acting, move electrodes so that arc volts are held to nominal average value. Production *goes up!*

In one plant this smooth, fast-acting amplifying generator actually permitted *one or more extra "heats" per day.* This was achieved on a furnace operating side-by-side with two identical units equipped with conventional control.

If you've had trouble keeping your furnace power supply stable, find out about the new Allis-Chalmers control built around the "Regulex" exciter. *It uses no contacts or motor line contactors!*

For complete information on the new "Regulex" exciter, call our district office near you . . . today. Or write direct to ALLIS-CHALMERS MFG. CO., MILWAUKEE, WISCONSIN.

A-1617

ALLIS-CHALMERS

WE WORK FOR VICTORY — WE PLAN FOR PEACE

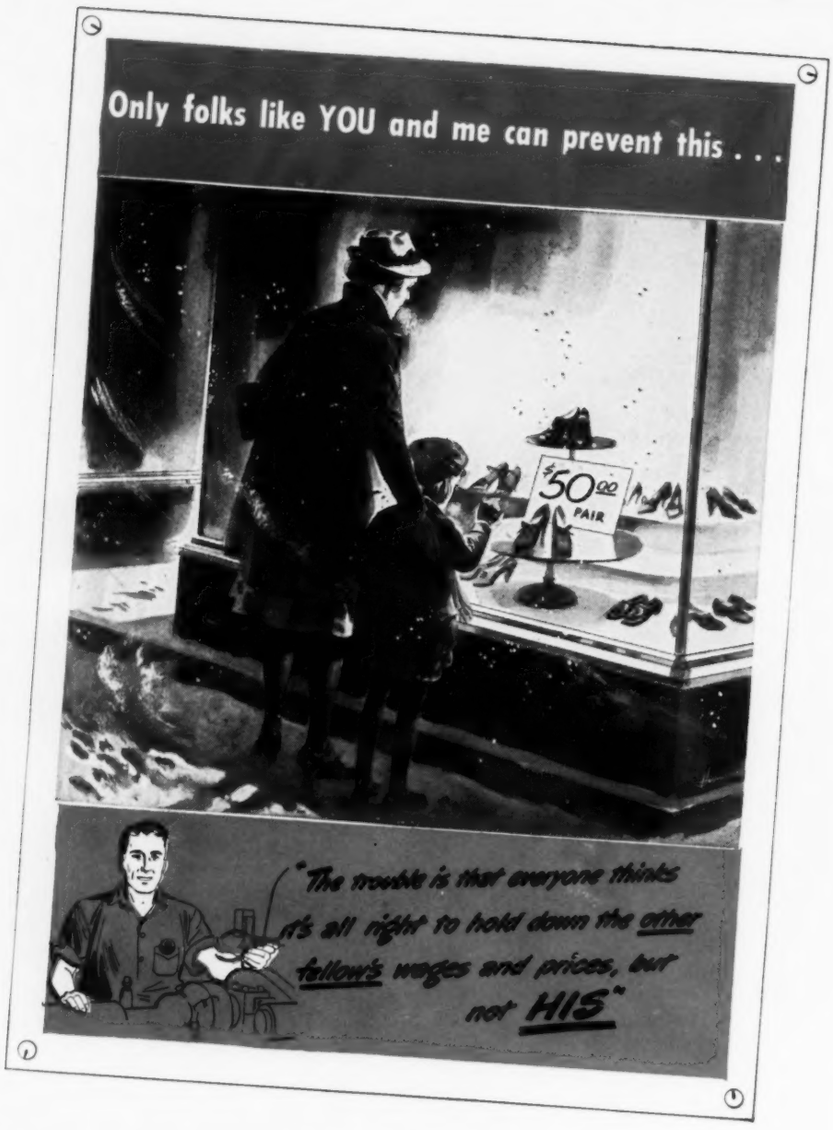
MATERIALS HANDLING *Short Cut*

TRADE **AUTOMATIC** MARK

Here is the proved shorter, quicker, easier, and more economical way to handle materials from receiving to storage to process, back again to storage or shipping. The proving ground is a wide variety of industries handling materials of many types. You increase storage capacity — your handlers get more done in much less time without fatigue. Find out how you can apply these "AUTOMATIC" Fork Lift Trucks to your materials handling. Write today.

AUTOMATIC TRANSPORTATION COMPANY
Div. of the Yale & Towne Mfg. Co.
47 WEST 87th STREET · CHICAGO 20, ILLINOIS
MANUFACTURERS FOR OVER 35 YEARS
Electric Propelled INDUSTRIAL TRUCKS

These five trucks are used in a north-eastern Ohio steel plant for handling tin plate from sorting room to boxing department, from boxing department to warehouses, and from warehouses into cars. Loads range up to 5000 lb. and are 24" x 28" in size.


Only folks like YOU and me can prevent this . . .
$50.00 PAIR
"The trouble is that everyone thinks it's all right to hold down the other fellow's wages and prices, but not HIS"

Put up this poster in your plants or offices

Our Government is engaged in another desperate war right now . . . the war against rising costs, climbing wages, spiraling prices. It is fighting to prevent runaway prices *now* and to prevent the depression which would surely follow.

Much of our Government's planning . . . many of the functions of whole departments . . . many current "campaigns" . . . are all tied into this.

That's why we have the OPA and ceiling prices. That's why we have roll-backs. That's one reason we have War Bond campaigns. That's why we have salary, wage and rent freezes. That's one of the reasons for boosting taxes. That's why we have restrictions on installment selling.

The greatest weakness in the fight against inflation is that everyone thinks it's all right to hold down the other fellow's wages and prices, but not his.

Will *you* help in this fight? It's your battle.

If you would like to help this fight by displaying this poster, use the coupon below for free copies.—Koppers Company and Affiliates, Koppers Bldg., Pittsburgh, Pa.

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

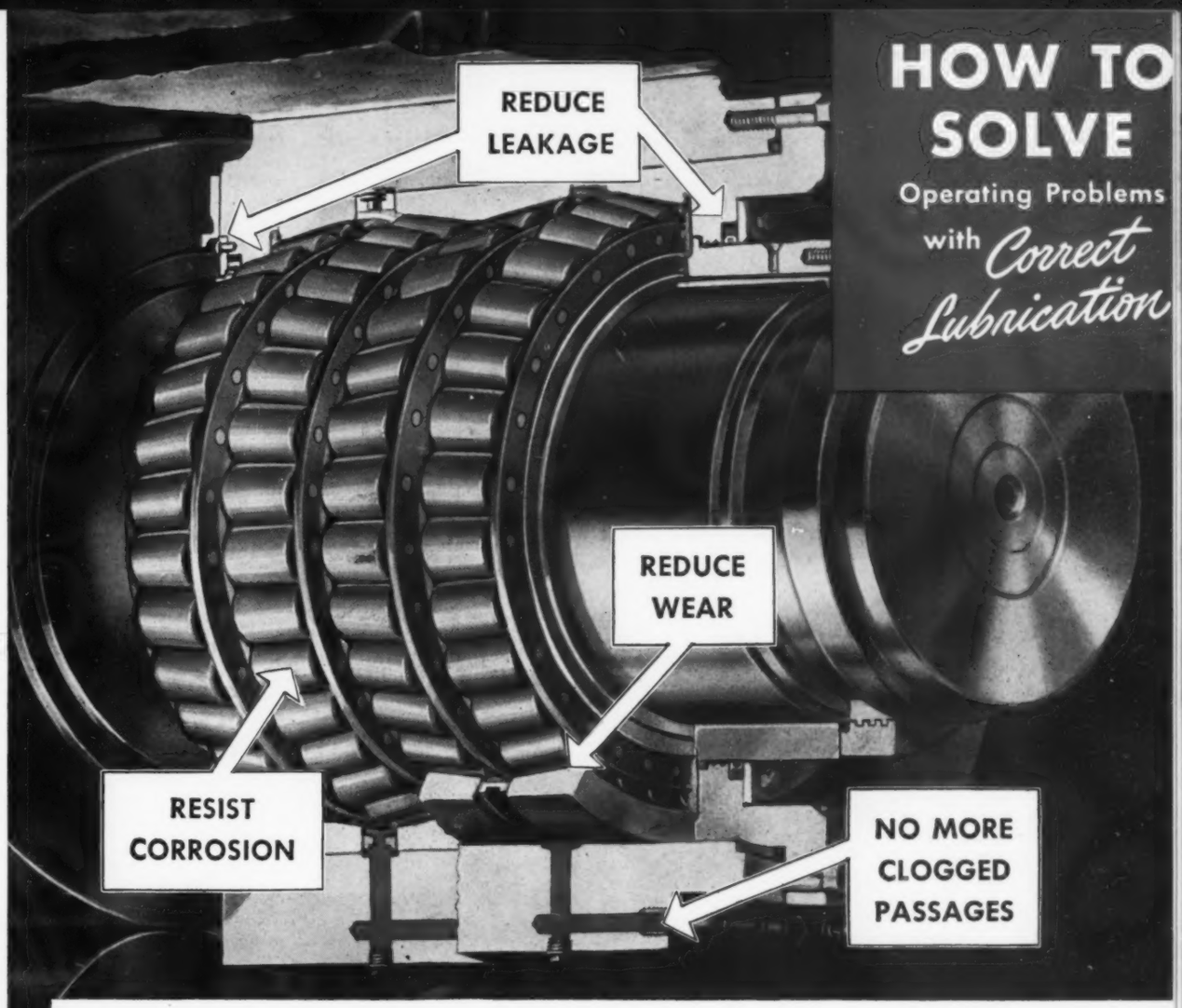
Please send me_____copies of your High-cost-of-living poster.

YOUR NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION



HOW TO SOLVE Operating Problems with *Correct Lubrication*

Brand New Type Grease Ups Steel Mill Output!

HERE'S A NEW GREASE that was designed expressly for steel mill service — Gargoyle Sovarex L Grease. *There is no other grease made that combines all its properties!*

This grease has been extensively tested in service in some of U.S.A.'s largest steel mills. Where it was used formerly experienced wear disappeared. Machine outage time was materially reduced. Production increased.

The importance of this new grease to the steel industry cannot be overemphasized.

GARGOYLE SOVAREX L GREASE HAS THESE IMPORTANT ADVANTAGES:

1. Maximum resistance to softening at high temperature. *Result:* reduced leakage.
2. Resists water. Oil film stays put. *Result:* resists corrosion... prevents wear.
3. Resists separation. *Result:* oil lines and passage are not clogged... bearing failures from this cause prevented.
4. High consistency index. *Result:* permits easy feeding with temperature variations.
5. Extra load carrying ability. *Result:* maximum protection against wear.

GARGOYLE Lubricants

SOCONY-VACUUM OIL COMPANY, INC.— Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California

USE SOVAREX L GREASE

AIRCO'S *Complete Oxygen Service*

MEETS ALL THESE REQUIREMENTS

AIRCO HIGH PURITY OXYGEN

Guaranteed 99.5% pure . . . uniform in quality from coast to coast . . . assures maximum speed and economy in metal cutting and promotes greater efficiency in welding. For example, a mere ½ of 1% difference in purity (between 99.0% and 99.5%) means 10% faster cutting and 10% less oxygen consumption.

AIRCO NATION-WIDE DELIVERIES

Airco's conveniently-located plants and warehouses assure dependable oxygen deliveries throughout the nation. Whether your monthly requirements are 200 cu. ft.—20,000—or several million cubic feet of oxygen, Air Reduction will meet your individual requirements.

ALSO

A complete line of:

Apparatus
Equipment
and Supplies

used in cutting, welding and all other applications of the oxyacetylene flame.

Also:

Acetylene Generators
National Carbide

And:

Wilson Arc Welder
(DC and AC)
Airco Electrodes

BUY
UNITED STATES
WAR BONDS

Plus AIRCO FIELD ENGINEERING SERVICE

Air Reduction nation-wide Field Engineering Service provides technical assistance to all its customers on every application of the oxyacetylene flame or the electric arc—including the development of mechanical procedures for flame and arc applications; detailed plans for pipeline gas distributing systems; and every other type of assistance required for the efficient use of Airco products.

AIRCO WILSON

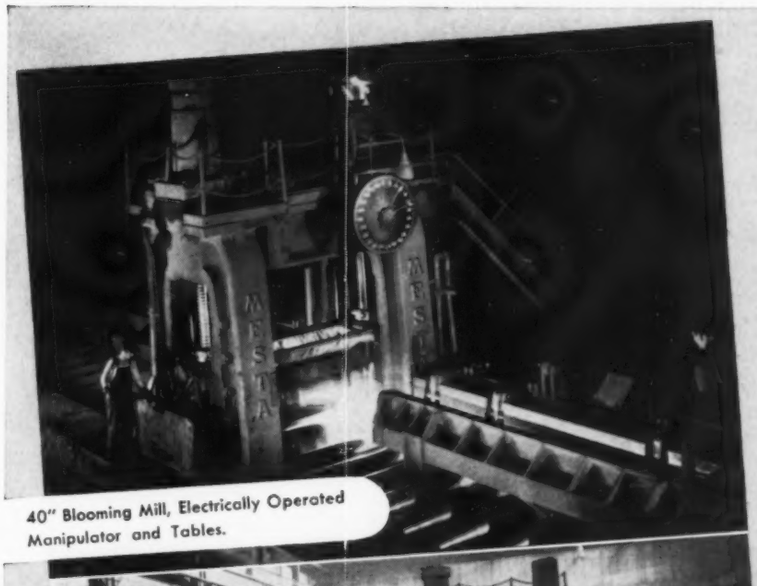
AIR REDUCTION

General Offices: 60 EAST 42nd STREET, NEW YORK 17, N. Y.

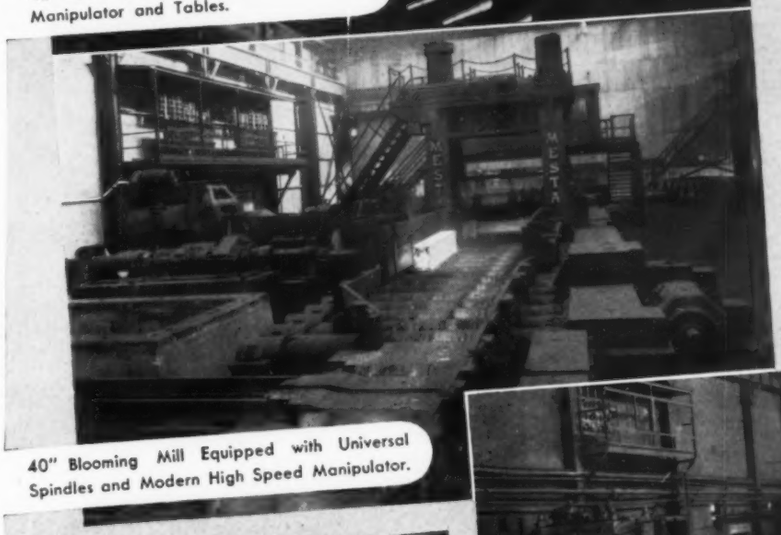
In Texas: MAGNOLIA AIRCO GAS PRODUCTS CO. • General Offices: HOUSTON, TEXAS

OFFICES AND DEALERS IN ALL PRINCIPAL CITIES

MESTA
BLOOMING AND SLABBING MILLS

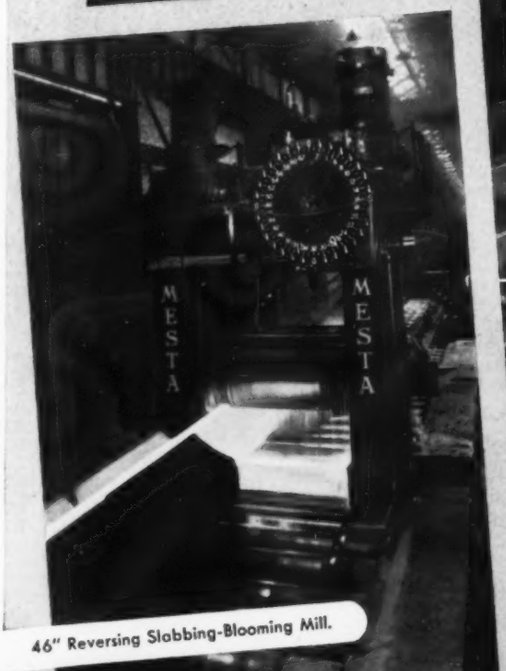


40" Blooming Mill, Electrically Operated Manipulator and Tables.



40" Blooming Mill Equipped with Universal Spindles and Modern High Speed Manipulator.

40" Blooming Mill and Table.



46" Reversing Slabbing-Blooming Mill.

46" Reversing Slabbing-Blooming Mill with Manipulators and Tables.

MESTA MACHINE CO., PITTSBURGH, PA.

OUR JOB
BETTER ROLLS FOR GREATER PRODUCTION
PITTSBURGH ROLLS
PITTSBURGH ROLLS DIVISION of
BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.

JOBS IN PEACE TIME

To get music you encourage musicians . . . .
To get paintings you encourage artists . . . .
Jobs are made by men of daring, initiative and creative thought who risk something in starting a project . . . men who then contract with others to help bring their ideas to fulfillment.

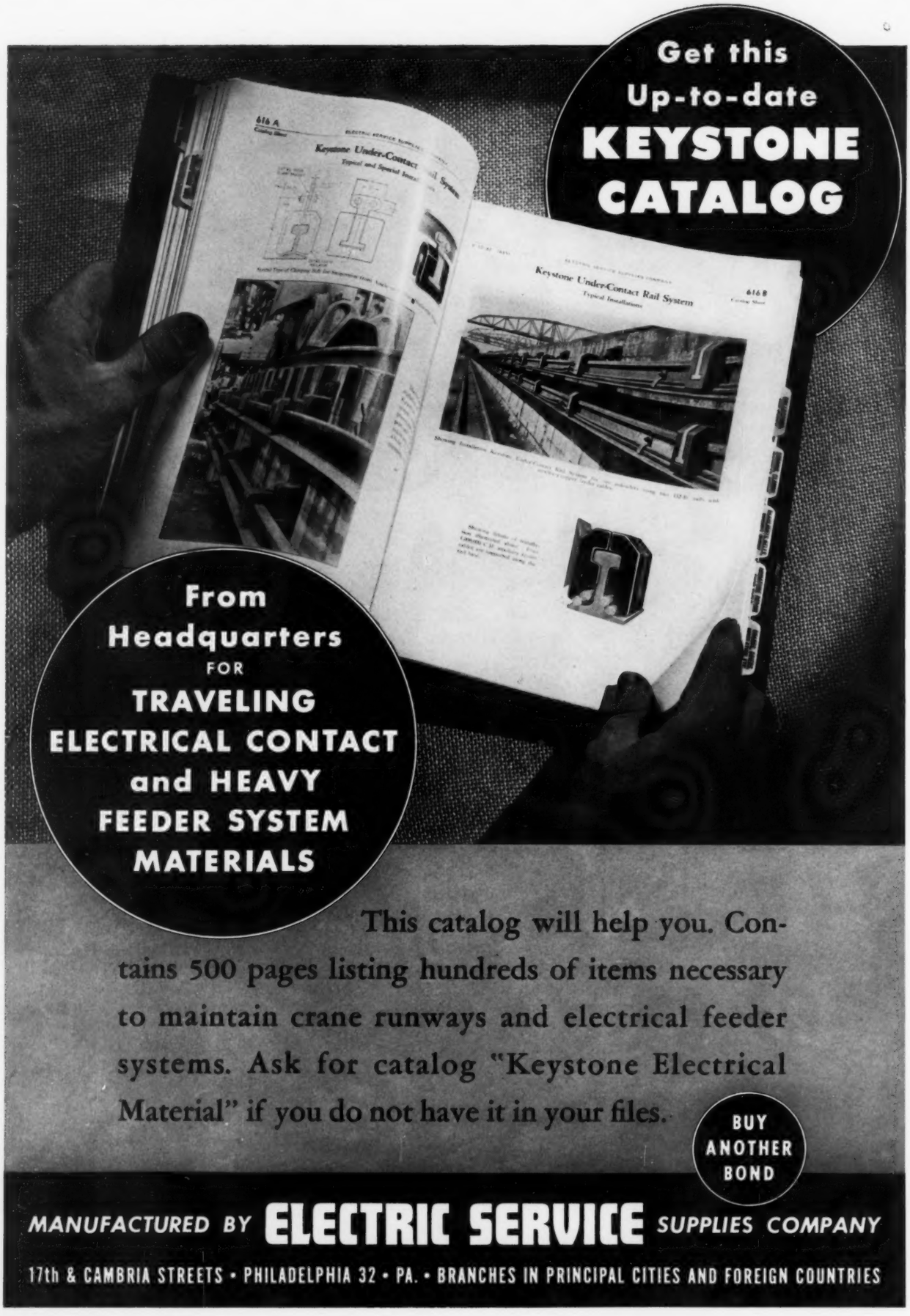
". . . the nation which wishes to be great, must place enterprise ahead of security. It must regard innovators, experimenters, starters of enterprises, as peculiarly useful citizens and go out of its way to furnish them a congenial and hospitable environment . . . It must strive to increase the proportion of its citizens, who become experimenters and innovators and who make their living, not by getting on someone else's payroll, but by creating payrolls of their own."

SUMNER H. SLICHTER
Professor of Economics
Harvard University

NORTH AMERICAN for COMBUSTION

THE NORTH AMERICAN MANUFACTURING COMPANY
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL
BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES
CLEVELAND 4, OHIO

PHOTOS BY LAMBERT


Get this
Up-to-date
KEYSTONE
CATALOG
Keystone Under-Contact Rail System
From
Headquarters
FOR
TRAVELING
ELECTRICAL CONTACT
and HEAVY
FEEDER SYSTEM
MATERIALS
This catalog will help you. Contains 500 pages listing hundreds of items necessary to maintain crane runways and electrical feeder systems. Ask for catalog "Keystone Electrical Material" if you do not have it in your files.
BUY
ANOTHER
BOND
MANUFACTURED BY ELECTRIC SERVICE SUPPLIES COMPANY
17th & CAMBRIA STREETS • PHILADELPHIA 32 • PA. • BRANCHES IN PRINCIPAL CITIES AND FOREIGN COUNTRIES

Precision WIRE FLATTENING

AT 1200′ PER MINUTE!

In the plant of a large electric company, two 3-stand tandem wire flattening mills are finishing wire for war at 1200 feet per minute. Good design keeps them producing—good design not only of the mills but also of SKF Double-Row Cylindrical Roller Bearings that assure :

- ***Smoothness*** because of their large number of staggered rollers.
- ***Maintenance of gage*** because of their precision rollers made by special methods.
- ***Rigidity*** because tapered seats permit accurate control of internal fits.
- ***Low Temperature*** because of their extremely low friction. 5417

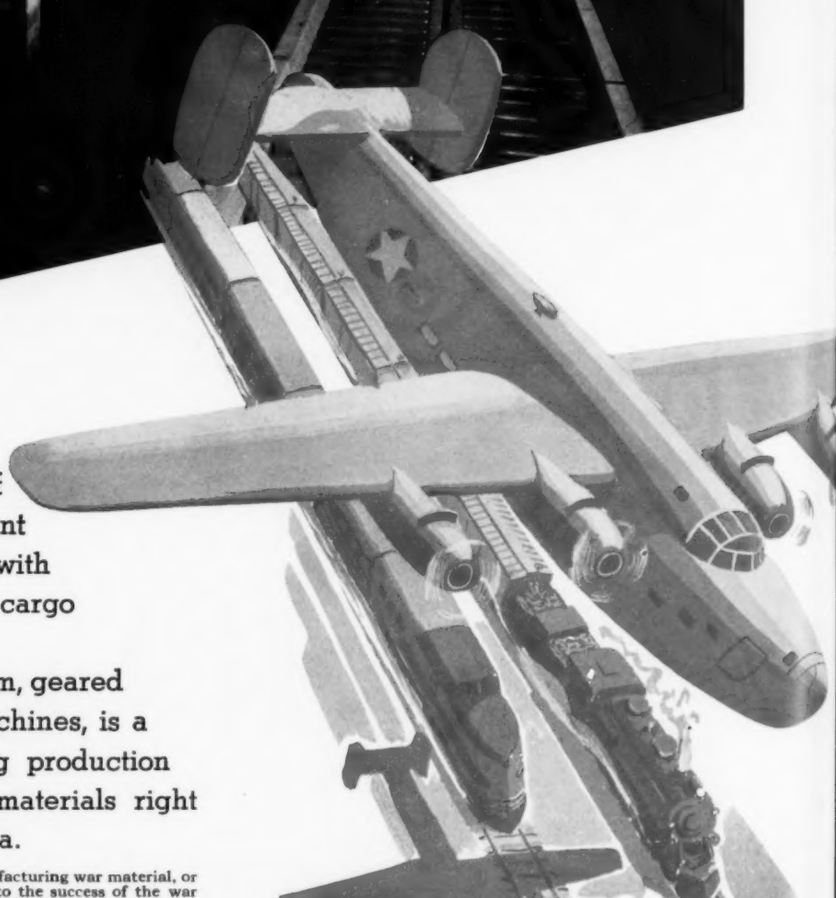
SKF INDUSTRIES, INC., PHILA., PA.

SKF
ROLLER BEARINGS

• Three-stand wire flattening mill built by Waterbury-Farrel Foundry & Machine Company.

Common Carriers

VITAL TO WAR SUPPLY MOVEMENT



SPEEDY, ON-TIME TRANSPORTATION of materials, supplies and parts within a plant ranks in importance to the war effort with America's railways, trucks, ships and cargo planes.

A well-engineered Conveyer System, geared to the speed of workers and machines, is a practical method of improving production from the receiving of raw materials right through to the shipping area.

If you are manufacturing war material, or anything vital to the success of the war effort, you can get Mathews Conveyers to handle that material. Rely as usual on your Mathews Engineer.

MATHEWS CONVEYERS FOR MECHANIZED PRODUCTION

MATHEWS CONVEYER COMPANY ELLWOOD CITY PENNSYLVANIA

BRENT WILEY, *Editor*
T. J. ESS, *Associate Editor*
JAMES D. KELLY, *Business Manager*
JAMES R. SCOTT,* *Production Manager*

Board of Directors

PRESIDENT
FRANK E. FLYNN
District Manager
Republic Steel Corporation
Warren, Ohio

1ST VICE-PRESIDENT, C. L. McGRANAHAN, *Assistant General Superintendent,* Jones and Laughlin Steel Corporation, Pittsburgh Works,, Pittsburgh, Pennsylvania
2ND VICE-PRESIDENT, J. L. MILLER, *Assistant Chief Combustion Engineer,* Republic Steel Corporation, Cleveland, Ohio
TREASURER, J. S. MURRAY, *Chief Electrical Engineer,* Follansbee Steel Corporation, Follansbee, West Virginia
SECRETARY, FREEMAN H. DYKE, *Superintendent, Blooming, Bar and Hot Strip Mills,* Wheeling Steel Corporation, Steubenville, Ohio
PAST PRESIDENTS: THOMAS E. HUGHES, *Superintendent of Maintenance,* Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania
WILLIAM A. PERRY, *Superintendent, Electrical and Power Departments,* Inland Steel Company, Indiana Harbor, Indiana
HONORARY DIRECTORS: JAMES FARRINGTON, *Electrical Superintendent,* Wheeling Steel Corporation, Steubenville, Ohio
A. C. CUMMINS, *General Superintendent,* Youngstown District, Carnegie-Illinois Steel Corporation, Youngstown, Ohio
WALTER H. BURR, *Electrical Superintendent,* Lukens Steel Company, Coatesville, Pennsylvania
DIRECTOR-AT-LARGE, J. D. JONES, *Chief Engineer,* Youngstown Sheet and Tube Company, Youngstown, Ohio
DIRECTORS: E. W. TREXLER, *Superintendent, Mechanical Department,* Bethlehem Steel Company, Johnstown, Pennsylvania
H. R. ZIMMERMAN, *Superintendent, Maintenance Department,* Carnegie-Illinois Steel Corporation, Electrical Division, Gary Sheet and Tin Mills, Gary, Indiana
N. C. BYE, *Chief Engineer,* H. Disston and Sons, Inc., Philadelphia, Pennsylvania
A. G. DELANEY, *General Superintendent,* Republic Steel Corporation, Gadsden, Alabama
E. J. WAGAR, *Superintendent, Steam Efficiency and Combustion,* Jones and Laughlin Steel Corporation, Otis Works, Cleveland, Ohio
W. H. COLLISON, *Superintendent,* By-Product Coke Plant, Great Lakes Steel Corporation, Ecorse, Michigan
L. R. MILBURN, *Electrical Engineer,* Great Lakes Steel Corporation, Ecorse, Michigan
A. W. STEED, *Superintendent, Maintenance,* American Rolling Mill Company, Middletown, Ohio
A. S. GLOSSBRENNER, *General Superintendent,* Youngstown District, Youngstown Sheet and Tube Company, Youngstown, Ohio

Managing Director
BRENT WILEY
Empire Building
Pittsburgh, Pennsylvania

*United States Army

IRON AND STEEL ENGINEER

NOVEMBER · 1943
VOL. XX NO. XI

In This Issue

The Design of Blooming and Slabbing Mill Elements — by H. H. Talbot, Senior Engineer, United Engineering and Foundry Company, Pittsburgh, Pennsylvania... 37

Discussion: The Design of Blooming and Slabbing Mill Elements — presented by F. C. Biggert, Jr., Louis Moses and C. P. Hammond..... 47

A New Soaking Pit Design — by Joseph Sparks, Swindell-Dressler Corporation, Pittsburgh, Pennsylvania.... 48

Discussion: A New Soaking Pit Design — presented by J. L. Miller, C. J. Wyrough, A. J. Cochrane, B. C. Wells, R. A. Lambert, A. J. Fisher and Joseph Sparks..... 52

Main Roll Drives for Blooming and Slabbing Mills — by R. H. Wright, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.... 55

Discussion: Main Roll Drives for Blooming and Slabbing Mills — presented by G. E. Stoltz, J. D. Jones, E. C. Marshall, R. H. Wright and W. A. Perry..... 59

Scheduling the Primary Mills — by Alex Montgomery, Jr. and J. B. Holbrook, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania..... 62

Discussion: Scheduling the Primary Mills — presented by Louis Moses, J. B. Holbrook and John A. Hagan.... 67

Flakes and Their Prevention — by O. A. Bamberger, Mechanical Superintendent, Republic Steel Corporation, Massillon, Ohio..... 68

Discussion: Flakes and Their Prevention — presented by C. M. Lichy, H. M. Smith, O. A. Bamberger, W. I. McInerney, Nick Carter, R. Sergeson and C. P. Hammond..... 72

A. I. S. E. Standard Design for Crane Track Wheels..... 75

Continuous Production Line for Tubular Railway Axles.... 78

Reclaimed Sewage Water for Industrial Uses — by L. F. Coffin, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.. 80

Discussion: Reclaimed Sewage Water for Industrial Uses — presented by N. D. Kenney, J. L. Hellman, W. P. Hill, H. L. Nelson, L. L. Jenne, L. F. Coffin and H. D. Esterly..... 88

Meet the Equipment Manufacturer..... 98

Latest Design and Equipment for the Industry..... 116

Items of Interest..... 134

Index to Advertisers..... 143

Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS

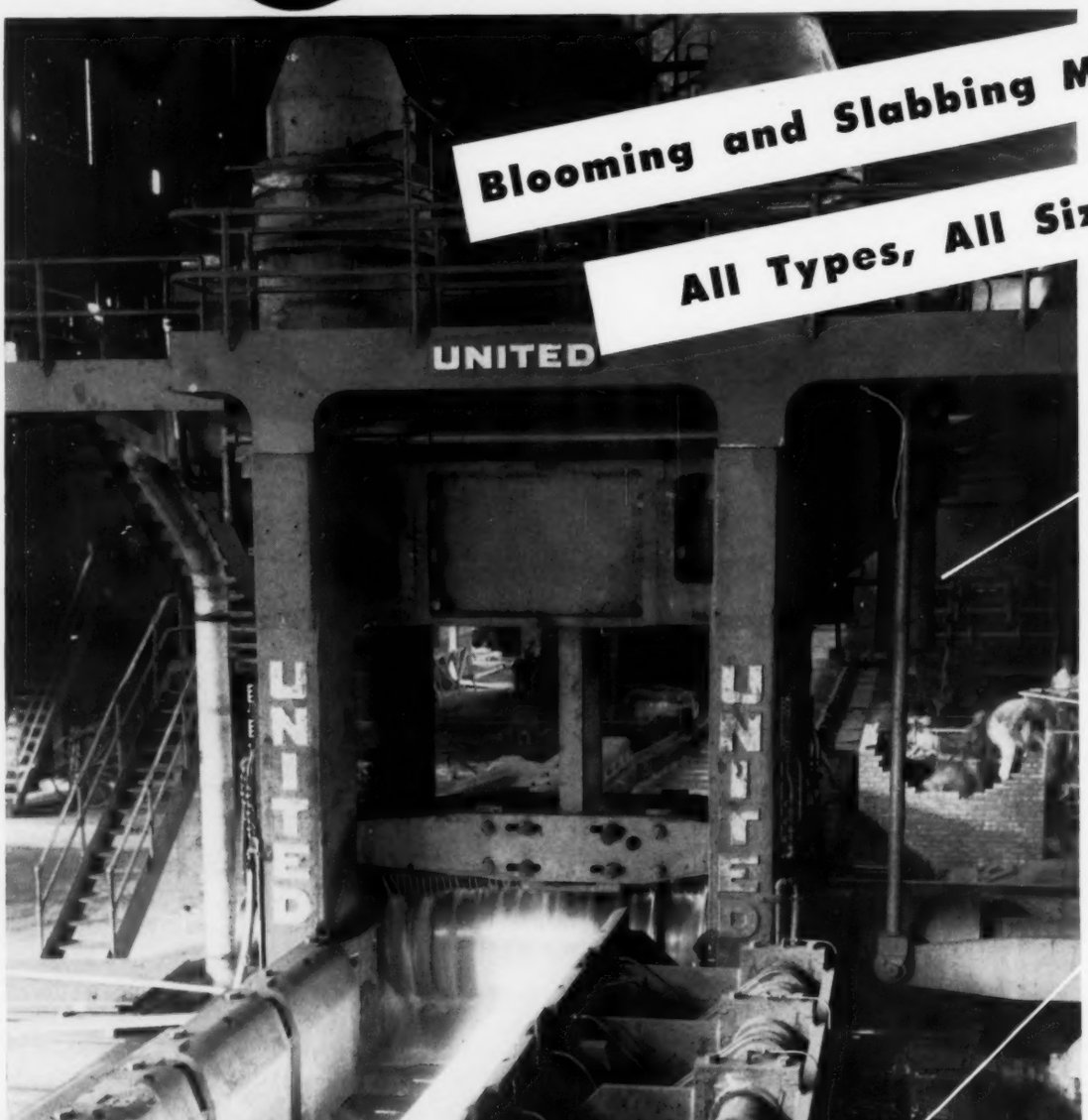
Entered as second-class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expression of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility. Copyright, 1943, The Association of Iron and Steel Engineers

Single Copy Foreign Prepaid $2.00 Single Copy $1.50
Subscription price in U. S. & Canada..... $ 7.50 per year
Subscription price in foreign countries..... $10.00 per year

PLASTIC BINDING U. S. PATENT NO. 1970291 LICENSE NO. 126

UNITED



UNITED
ENGINEERING AND FOUNDRY COMPANY
Pittsburgh, Pennsylvania

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment.

Products Manufactured By UNITED

★ ★ ★

Mills

Blooming
Slabbing
Plate
Universal 2, 3, 4-high
4-High Hot Strip
Bar
Rail & Structural
Merchant Rod
Skelp
Pipe and Tube
2 and 4-high Cold Strip
Sheet
Tin

In all types: Single Stand, One Way or Reversing, Tandem Continuous, etc.

For Carbon Steel, Alloy Steels, Copper, Brass, Aluminum and other Non-Ferrous Metals

Rolls

"UNEFCO" Green Grain and Chill
Wabblers
UX Chill and Grain
H.D. Spec. Process
United Special Steel
United Carbon Steel
United Nickel Chill
United Straight Chill
United Adamite
United Moly. Chill
Lincoln Special
United VAN-X
United Spec. Process
United Unidense
United Super X

Auxiliary Equipment

Ingot Cars
Manipulators
Edgers
Mill Tables
Transfers
Hot Beds
Structural Straighteners
Bloom Shears
Vertical Shears
Hot and Cold Saws
Rod Reels
Hot Strip Reels
Flying Shears
Shearing Lines
Slitting and Trimming Lines
Precision Levellers
Squaring Shears
Portable Crop Shears
Lever Shears
Roll Lathes
Cone Type Uncoilers
Coil Boxes
Upcoilers and Downcoilers (Strip)
Cold Strip Reels
Gear Reduction Units
Generated Gears and Pinions
Continuous Strip Picklers
Rotary Strip Picklers
Electrolytic Strip Cleaning Lines
Electrolytic Strip Tinning and Coating Lines
Material Handling Equipment
Steam Hydraulic Forging Presses
Electro-Hydraulic Forging Presses
Electro-Hydraulic Piercing Presses
Universal Couplings
Welding Positioners
Pressuremeters
Heavy Welded Steel Constructions
Annealing Boxes
Steel Castings

ARMY
E
NAVY
MOORE RAPID
Lectromelt
FURNACES
Sizes 100 tons to
PITTSBURGH LECTROMELT
FURNACE CORPORATION
PITTSBURGH, PENNA.

THE DESIGN OF *Blooming* AND *Slabbing Mill Elements*

. . . . not a handbook of instructions for the designer, this paper nevertheless touches many of the high spots in the design of blooming mills . . . .

by H. H. Talbot, SENIOR ENGINEER
United Engineering and Foundry Company
PITTSBURGH, PENNSYLVANIA

▲ THE design of any unit of equipment is primarily predicated upon the job the unit has to do, both individually, and as a part of the larger whole, including auxiliary and cooperating equipment. Similarly, the detail parts are inter-related and must be adequate for their respective functions.

The investment cost, frequently of primary influence, is at least a major consideration. This item is the reflection of manufacturing costs, which are largely determined by the design, relative to the materials, weights, machining and labor time, specified or required.

The designer also must have his eyes continually focused upon the problem of operating costs as affected by such features as: accessibility, lubrication, assembly and dissembly, renewal or replacing of parts, adjustment of parts, roll changing, etc.

Generally true for all mill machinery, but particularly for large units, the infrequency of new installations is great. During these dormant periods advances and improvements of allied equipment and processes occur, and to meet this trend toward refinement, the new design must incorporate desirable improved features. Also the requirements of production vary for particular installations. Therefore, absolute standardization is impractical and such equipment is thus largely "tailor made".

To clarify the picture of "the job to be performed" and the place occupied by the blooming and slabbing mill in the general process of rolling steel product, let us briefly review certain generalities.

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 10, '43

Both of these mill types are "primary units", rolling the ingot as it comes from the soaking-pit furnace, to intermediate sections which will be subsequently rolled or forged on other mills or equipment.

The bloomer produces "blooms" and slabs; making all passes, flat and edging, on the same pair of rolls. Blooms (rectangular or square) supply stock for bar or billet mills, rod, rail, beam, and structural shape mills. Slabs form stock for hot-strip mills, a few sheet-bar mills, and frequently for plate mills. The slabbing mill consistently produces slabs, though sections similar to blooms are possible. Though some mills are arranged for making the heavy edging passes on the horizontal rolls, it is commonly differentiated from the bloomer in that the edging passes are made between a pair of vertical rolls. The slabs form stock for hot-strip and plate mills.

Several typical arrangements of the mill in the plant layout may be cited as follows:

As a separate unit, delivering to shears, cooling and piling equipment for subsequent conditioning and re-heating prior to re-rolling.

In proximity to, or in line with, secondary mills to also permit of direct rolling (without reheating) on these mills; or with intervening holding or wash-heat furnaces.

A primary bloomer, delivering to a secondary smaller bloomer which in turn delivers directly to, as example, a continuous bar mill.

While there are a good many three-high bloomers, (necessarily a "fixed pass" type) particularly in Europe, and which with their tilting tables, finger manipulators, and non-reversing drives, form very

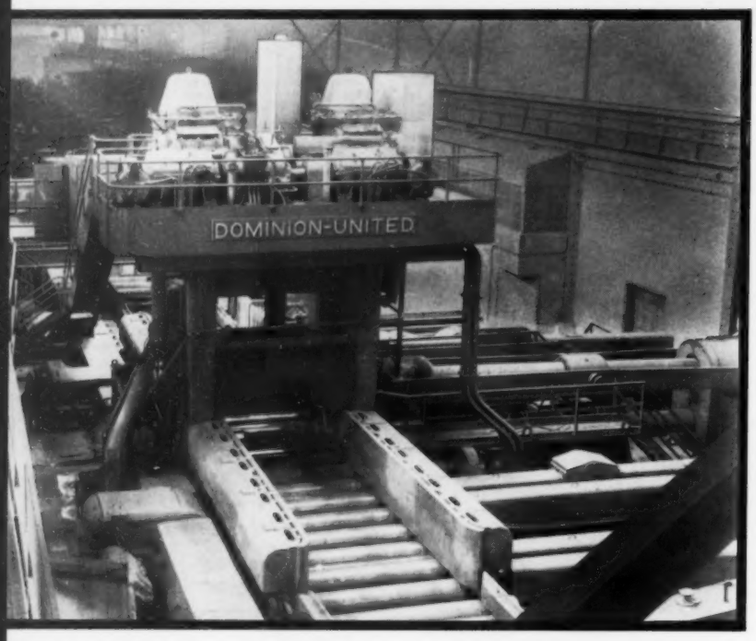


Figure 1 — General view of a 44 in. two-high reversing blooming mill installed in a Canadian plant.

efficient units in the smaller size range, the scope of this paper will be restricted to the consideration of the two-high, motor driven, reversing type.

The mechanical equipment directly concerned with the steel in the rolling process includes: the roll stand itself with its rolls and screwdowns; the front and back feed rolls and the front and back roller tables; the ingot receiving table ahead of the "front" table; the delivery table following the "back" table; the manipulator incorporated in the front and back tables, with its "tilting fingers".

The front and back tables reverse rotational direction in harmony with the mill rolls and approximate their linear or surface speed. For extremely long lengths of steel, the receiving and delivery tables may be required to reverse.

The ingot from the soaking pits is delivered to the receiving table, thence conveyed to the front table where, if received flat, it is turned on edge and shifted sidewise by the manipulator "fingers" and side guards in line with the pass. It then enters the rolls. Thus by a process of "in and out" of the mill, turning and shifting to pass position, after numerous passes the final reduced section is obtained and the steel travels down the line. After each pass the top roll is raised or lowered, by the screwdown, to give the proper space between rolls, or "roll opening", to suit the thickness of the steel and reduction of the next pass. This adjustment can start as soon as the piece leaves the rolls, but must be completed prior to engagement on the next pass. Thus for a slabbing bloomer or a high-lift slabber, where edging is performed on the horizontal rolls, it is evident that top roll movement may be considerable, perhaps a matter of 50 or more inches. Any excess time consumed in this adjustment over the time required for deceleration and acceleration of the mill, manipulation and retravel, is "lost time". Hence the requirement for a fast screwdown on this type of mill.

Substantially the same equipment arrangement accompanies the high-lift slabber.

For the low-lift slabbing mill with "attached" or "separated" vertical rolls, a simple side adjusting manipulator only is required and the screwdown can afford to be relatively slow.

The main drive for the horizontal rolls may be either the usual single motor type with pinion stand and normal spindles, or the dual motor type without pinion stand and each motor driving a single roll. The latter type seems to be preferably applicable to the largest mills (54 in.) where the increased horsepower available in two normally powerful motors is desirable.

The vertical rolls of "universal mills" can advantageously be driven from gearing incorporated with the main pinion stand. For the slabber with "attached" verticals, a separate motor drive is general; and of course for the "detached" (some distance away from the mill), the separate motor is mandatory.

For reasons of available space, avoidance of scale falling onto the driving parts, and general accessibility, the drive shaft of the vertical rolls is "over-head". In some designs, the motor or motors, and drive proper are mounted directly on top of the housings or screwdown entablature. Two vertical main drive shafts are fixed as to position, and located so as to divide the lateral stroke of its respective roll as it is adjusted to accommodate the slab width, from minimum to maximum. The low ends of the drive shafts are fitted with universal joints and "vibrating" spindles serve to drive the rolls.

This arrangement is reasonably satisfactory for a low-lift mill, where the body length of the vertical rolls is relatively short and where the work done by the verticals is sufficiently small that the physical dimensions of the required motors can be accommodated over head. However, for a high-lift mill and as example, one having 45 in. x 80 in. horizontal rolls with 66 in. lift, with 36 in. x 80 in. verticals, driven by 3000 motor hp, and 18 in. minimum to 82 in. maximum roll opening required, the spindle length giving proper working angle, and the power to render this arrangement impractical. A horizontal splined drive shaft, (through drive units which move with each roll in fixed vertical alignment) driven directly from the motor, (or motor and drive) located adjacent and above the spindles, constitutes a very adequate arrangement for this condition, and in our opinion, a preferable design for any size edger of this "attached" type.

The edger unit itself is essentially a roll stand laid on its side, and attached to the main roll housings. Having bearings on both ends of each roll backed up by screws, the pairs of forged steel rails and the screw box housings correspond to built-up housings. Both roll units must move in unison in opposite directions symmetrically about the center line of the mill for pass opening adjustment, and should stroke beyond the ends of the horizontal roll bodies. Thus a screwdown is required for each.

These screwdowns are identical, except opposite hand. Each has a main screw back of each neck bearing, a spring mounted follower screw or pull-back, and a screw controlling the driving gear box. A vertical shaft,

with throw-out clutch, connects and drives the worms of all four screw worm-wheels. Both of these vertical shafts, through bevel gear units are driven by a single lay shaft and motor, all mounted on the over head slide rail housing of the roll drive gear boxes. As this edger unit corresponds very closely to a roll stand proper in the matter of detail design, further analysis of stresses and parts design will be omitted.

The manipulator, in general, consists of a pair of side guards, stroking laterally over the rollers of the front and back mill tables, on each side of the mill.

The guards on the drive side of each pair are in alignment, as are also the opposite two, driven respectively by two shafts. There are many types, but the rack and pinion type predominates and may be either electrically or hydraulically driven. Depending on the size of ingot or section to be manipulated, the height of guards may be up to 48 in. or so. Lifting fingers, always on the "front" and sometimes on the "back" manipulator also, are incorporated in the guard or guards toward the drive side. These have a vertical or near vertical stroke and serve to lift the piece by a corner in the process of turning it 90 degrees.

As affecting the design of the mill tables, as most of you have observed or can readily visualize, there is a tremendous impact shock on the table rollers when a 36 in. x 66 in. 33 ton ingot, turned from "on edge" to "flat" and beyond the retarding control of the side guards, actually drops onto the table. Shock absorbing devices located between the table rollers to alleviate this impact have been recently installed and in the writer's opinion should be very effective.

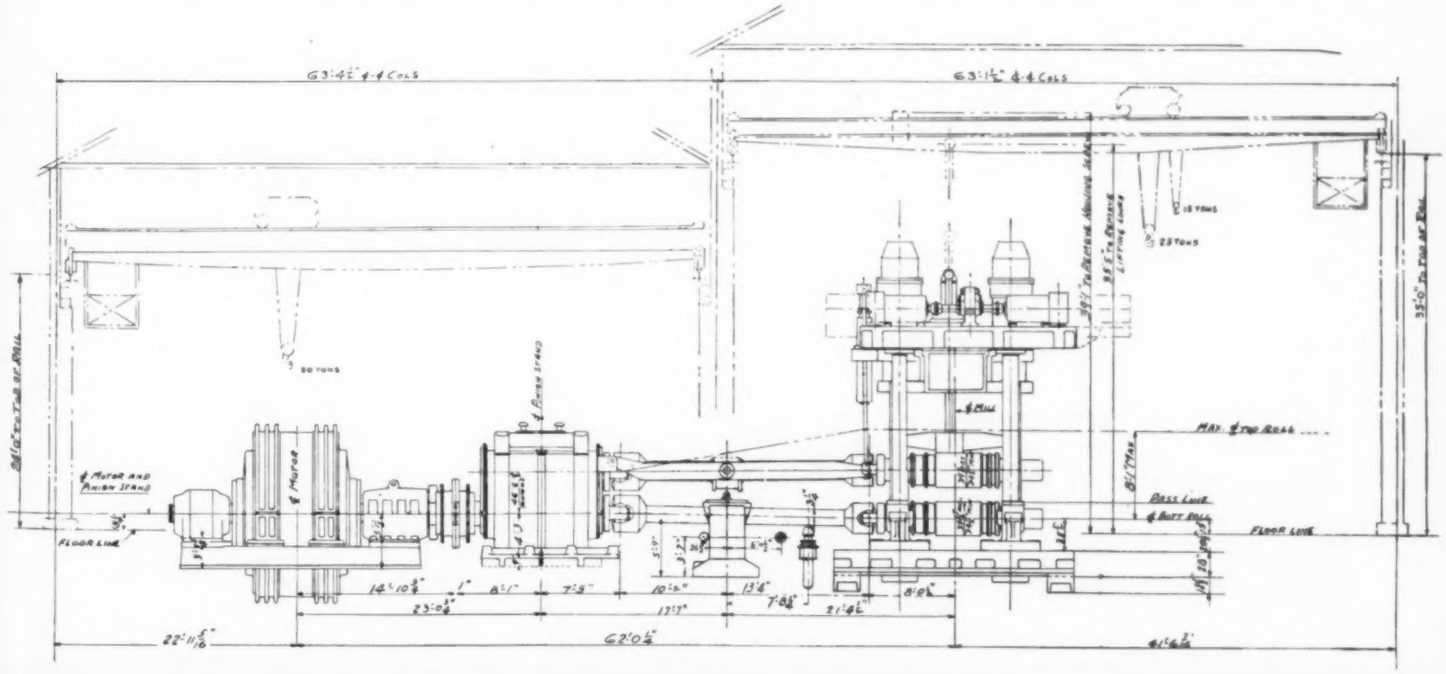
The roller tables are important items of equipment, and require careful design. Not directly affecting the design of the mill proper, suffice it to say that in common with the manipulator and all modern mill equipment, the trend has been toward refinement of design, incorporating high strength materials, roller bearings, hardened cut gearing, complete enclosures, advanced lubrication and good appearance.

Feed rollers are required to span the space between the table rollers and the roll in order to travel the relatively short ingots. Taking a lot of punishment from impact and pressure of the ingot or slab, they must be husky in body and necks. They are closely spaced and must be readily removable. Their proximity immediately affects the design of the housing in that their supporting bearings must be carried on or in the housing posts.

There are two alternative methods of doing this: put a hole through the post sufficiently large to extract the roller, with its sleeve bearing cartridge, outwardly through it. This applies to the roller nearest the mill roll, and permits a post section between the hole and the window. The outer roller is mounted in bearing seats with caps, at the outside of the post. Thus the housing is, at this point divided into two stress sections which are elongated beyond the normal post thickness and with proper contour reinforcement, to restore the stress area to slightly greater than the normal post area.

Alternatively, both rollers are mounted in capped bearings, one at the window face and the other at the outside face. This gives a single, likewise elongated and reinforced, section between the rollers. Water and mill scale is a source of trouble, particularly for the feed roller bearings and careful attention should be given to sealing and lubrication. Bronze, fabric and roller bearings have been used.

Figure 2 — This section through the mill stand, pinions and drive of a 46 in. mill is typical of the modern blooming mill installation.



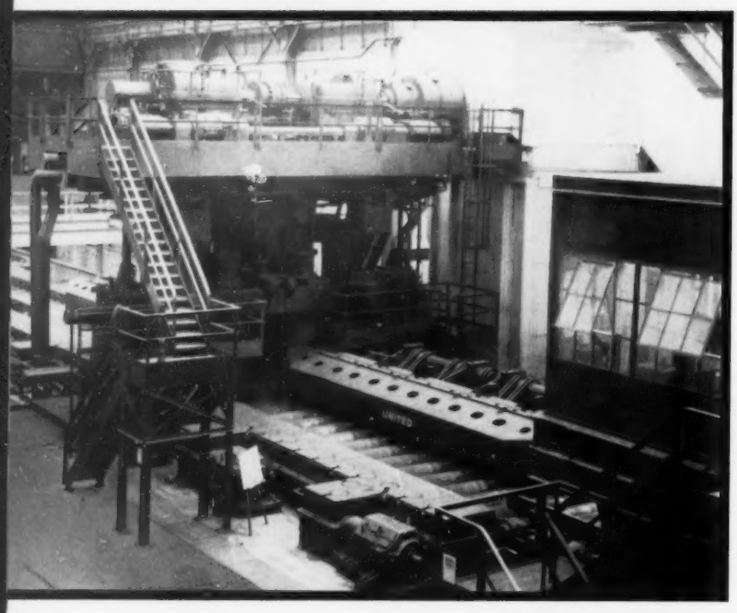


Figure 3 — This 45 in. x 80 in. universal mill is a recent installation in the Pittsburgh district for the rolling of slabs.

It is impossible to synchronize the surface speeds of these rollers and of the mill rolls. Therefore, considerable "drag" or "push" ensues from the slab contact. It is therefore smart to drive each pair of rollers by a separate motor and drive operating off of the mill table control. This arrangement utilizes the resiliency of the motors load-speed characteristic and will save many a shut down, common when driven directly from the mill tables.

Roll changing is a more or less frequent necessity. This is commonly done, for medium size mills and sometimes for heavier mills, by means of counterweighted porter bar, by a sleeve utilizing the ingoing roll as a counterweight, or by a "C" hook. These methods handle the rolls singly, require overhead crane assistance throughout the operation, and seizure of the roll is by a socket fitting over the protruding extension to the roll neck.

The portable roll changing rig, in most modern large mills, has earned recognition as a necessary auxiliary. Consisting of a rack and pinion motor operated crosshead mounted on a rail frame, it is placed in position in a pre-arranged permanent mounting practically at floor level, and withdraws both top and bottom rolls (stacked), together with the bottom roll bearing chucks and the top roll carrier chucks. The ensemble is crane removed; the new ensemble of two rolls is mounted and pushed into the mill.

Contemplated use of such a rig affects the design of the bearing chucks and in a minor way, of the housings also.

The top roll balance is for the purpose of keeping the top roll necks in contact with the upper chuck bearings, the chucks tight up against the screw points, and the screw thread surfaces in contact. It must thus effect a constant lifting force sufficient to carry the weight of the roll, chucks and screws, plus an excess or over-balance to insure that the roll assembly will follow the screws on the "up" stroke. Excessive over-balance results in unnecessary screw and screw-box and step bearing wear. Unequal pressures on the screws is detrimental and provision should be made to equalize the screw loads by adjustment.

Two general types of balance are in use: overhead hydraulic cylinders connected to an accumulator system, and the underneath counterweight and lever type.

The hydraulic type is the neatest, easiest to handle for roll change, and probably the most generally used. A single cylinder, adjustably located off center of the top separator is preferable. Depending straps carry cross beams inside the windows, which in turn are attached to the carrier chucks.

The counterweight type consists of separate counterweighted levers fulcrumed at the under side of the housing bases, down in the scale pit, and acting on strut rods extending up through the housings to engage the carrier chucks. For roll changing, a system of latches is provided to hold the weights in "up" position and thus free the roll necks.

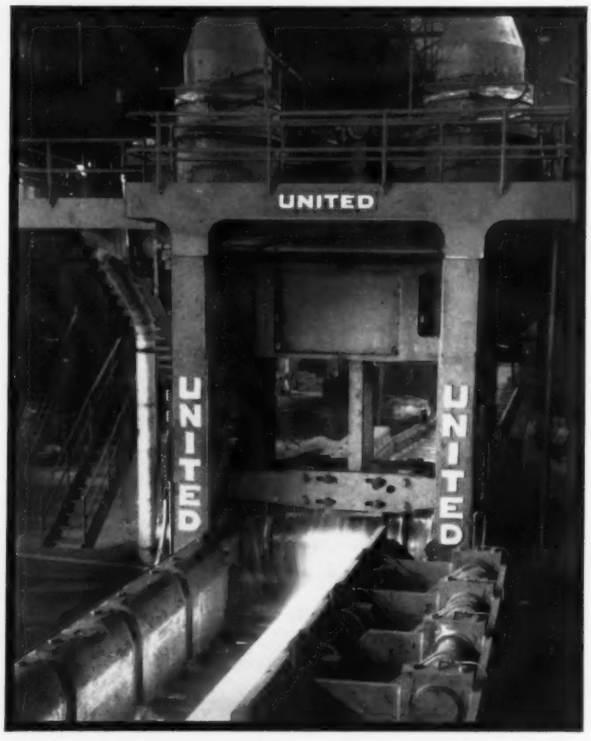


Figure 4 — Front elevation of a 46 in. reversing bloomer, showing side guard and manipulator arrangement.

The screwdown is a very essential part of the roll stand. Functioning to position the top roll to suit each pass, it operates up or down for each reversal of the rolls. It consists of two screws, one in each housing, operating in nuts or screw-boxes imbedded in the housing tops. The upper projecting portion, splined either square or preferably fluted, is enshrouded by the driving gear, sometimes a bevel gear, but preferably a worm-wheel. The driving pinions or worms are tied

together by a common drive shaft, with disconnecting clutch for roll leveling, which is suitably geared to the motor or motors.

The total gear ratio between the motors and screws is usually around 4:1 to 5:1.

Unlike some of the 4-high mills, it is never necessary to operate the screws during the pass and under the rolling load, except in case of a possible accidental jam when a backing off or upward relief stroke may be attempted. The screws however are always loaded to the extent of the "over-balance" of the balance system. The requirements then for the screws and nuts are those of an efficient bearing, together with ability to support statically the heavy rolling load.

Screw efficiency dictates a large thread angle or very coarse pitch. However, if too great an angle or "wedge" is used, the motor brakes will not be able to prevent the screws "backing off" under pass load. Therefore, a compromise is necessary, influenced by the frictional thread resistance and the holding power of the brakes. The usable pitch varies with the screw diameter. For large mills having around 15 in. diameter screws, the pitch will be 2 in. and single thread, resulting in screw speeds, at rated motor rpm, of about 20 fpm on high-lift (58 to 66 in.) mills, to perhaps 13 fpm on a low-lift (32 in.) universal slabber. Two 150 hp motors are usual for such high-lift mills.

Total WR^2 of all rotating parts, referred to the motor, and friction factors have direct bearing on the accelerating speed and power.

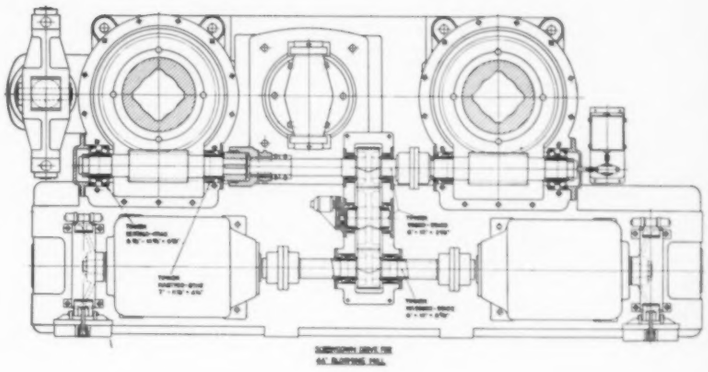
Screwdown control for pass setting is generally manually operated. However, the automatic control, capable of being set for any desired sequence of passes, provides a constancy of settings and is in high favor with many operators.

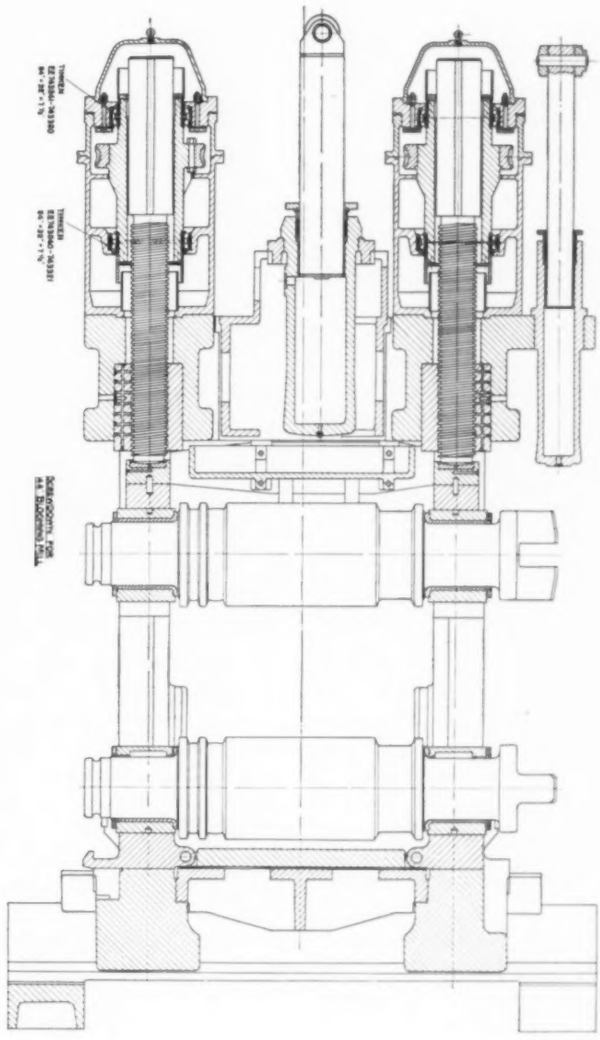
An indicator is a necessary part of the screwdown to visually advise the operator of position of the roll or the "roll opening." The conventional type consists of a large dial with indicating clock-like hands. More recently, the Selsyn system has been used. A small synchronous motor immediately drives a "producto-meter" (a glorified speedometer) or the hands of about a 24 in. dial, all located on the operator's desk in the pulpit. This unit is electrically tied to, or operated by, a small synchronous generator geared to the high speed screwdown shaft. The generator and motor being always "in step", exact and effective indication results.

The foregoing remarks are intended to outline some of the requirements and features of design.

All mechanical design is predicated on, and must conform to, the pressures and forces encountered. The theoretical designer, or even the expert in other classes of machinery, will be disappointed to find that mill machinery cannot, with safety, be closely designed to neatly cover the stresses as computed from known loads based on normal average or maximum conditions of operation. There are shock loads inherent even in normal use. There are inevitable accidental occurrences producing extreme overloads. Extreme hardship results from use under improper adjustment and lax corrective attention.

Engineers have frequently been accused of "engineering cowardice", but experience has proven that it is "better to be safe than sorry", as upkeep costs can soon out balance the initial cost saving of too closely proportioned parts.





Figures 5 and 6 — Sketches showing general arrangement of the mill screws and screwdown mechanism.

It is, however, absolutely necessary to know the normal forces and loads and to figure normal stresses on this basis. These figures serve as a yardstick and the designers' experience and educated judgment must establish the relationship of these stresses to the final desirable proportions.

Due to the fact that mills of this type have a long history, the general proportions are pretty well established for a given size. Also its capacity is well known. Knowing the product and tonnage to be produced, the mill size and power, for over-all economy, can be quickly specified. Also vice versa. Generally, where the great percentage of tonnage will be nicely accommodated by a certain size mill normally powered, modification of the rolling schedule for the small percentage of large sections (example, more passes) will be expedient rather than install an oversize unit.

For the matter of analysis of stresses and design of detail parts, it will be necessary to concentrate on a single example as typical. We will choose a modern three year old 46 in. x 100 in. blooming mill, rolling both blooms and slabs.

Mill practice will include perhaps ten different ingot sizes, some hot-top, some open-top, and some bottle-top, from 23 in. round and 23 in. x 25 in. to 26 in. x 58 in. and 32 in. x 42 in. and covering a weight range of from 7000 to 24,000 lb. Blooms 7 to 11 in. square and slabs 12 in. x 2½ in. to 53 in. x 4 in. to 11 in. are rolled from respective ingots. Taking up to 1½ and 2 in. maximum drafts for blooms, and up to 2 and 2½ in. maximums for slabs, depending on section and drafts, blooms take from 13 to 25 passes and slabs from 15 to 25.

Taking as a basis, certain typical early and late passes, for a medium bloom, and a slab of maximum width and weight, values of essential data have been computed as shown in Figure 7. These are based on the well known horsepower hours per ton curve for blooming mills, established by actual test and considered quite reliable for mild steel.

This mill is driven by an 8000 hp reversing motor, 0/50/120 rpm. Characteristics of such a motor are constant rated torque 0 to 50 and constant hp above 50 and subject to the usual overload capacities.

Though these figures are used in the following studies, it will be evident that in consideration of the power available, somewhat heavier drafts could be taken as far as power is concerned. Thus such possible maximum drafts would increase the figured stresses proportionately. The "rated" motor torque (8000 hp at 50 rpm) for up to base speed = hp x 5250 ÷ rpm = 840,000 ft-lb or 10,080,000 in-lb, and at 240 per cent load, is 2,016,000 ft-lb or 24,192,000 in-lb. At 95 per cent pinion stand efficiency (used for the table calculations) the latter becomes 22,982,400 in-lb to the rolls, or 11,491,200 in-lb to each roll, which is 132 per cent of the 8,700,000 in-lb shown for the tabulated early slab pass. Thus the stresses, in the following calculations could reach values 32 per cent greater, for this maximum motor torque, as a normal operating maximum. However, for an accidental "jam" or actual "stall", due to the flywheel energy of the motor rotor an abnormal torque could result. Its value would depend on the speed, at that time, and the time interval of the stoppage. This is purely an accidental condition and for reasonably designed parts may or may not cause a failure somewhere.

In the tabulated data it is evident that the earlier pass for the 24,300 lb ingot will set up the greatest stresses. In this case, the separating force between rolls (and therefore the pressure on each roll), P equals 2,980,000 lb. The driving torque on each roll, T equals 8,700,000 in-lb.

As the effect of the roll weights on the bending moments (minus for the top and plus for the bottom) is relatively small, we encounter no appreciable error by neglecting its consideration.

Figure 8 depicts the somewhat "off-center" loading for this pass and indicates the section moduli (both bending and torsional) for the critical sections of the roll.

By moments the neck loads are respectively:

$N_2 = 1{,}358{,}000$ lb at the driven end

$N_1 = 1{,}622{,}000$ lb at the free end

The total neck frictional torque for each roll, $T_f = 1{,}785{,}000$ in-lb, which incidentally is 20.5 per cent of the total input torque. The portion generated in each neck is proportional to its respective neck load, or $T_{fn2} = 814{,}000$ in-lb and $T_{fn1} = 971{,}000$ in-lb.

Driven neck N_2 at a section "outside" of the bearing is subjected only to torsion of 8,700,000 in-lb, which with $S_t = 2765$, gives a shear stress of 3140 psi. At the fillet section, it is subjected to a torsion moment of 8,700,000 — 814,000 or 7,886,000 in-lb with a stress of 2850 psi. This section also carries a bending moment $10N_2 = 13{,}580{,}000$ in-lb, and for $S_b = 1382$, a stress of 9800 psi. These combined on a "square root of the sum of the squares" basis indicate a resultant of 10,200 psi.

Obviously the section at groove (C) will show greater stresses than either (B) or (D). Section (C) carries the same 7,886,000 in-lb torque and with $S_t = 7700$ and 5300 respectively for "new" and "old" rolls, stresses of 1020 and 1490 psi. It also carries a bending moment of $38.5N_2 = 52{,}200{,}000$ in-lb and for $S_b = 3850$ and 2650, the stresses are 13,580 and 19,700 psi, respectively, for "new" and "old" rolls. The "combined" are negligibly greater.

Neck N_1: Section at fillet is subjected to its bearing frictional torsion of 971,000 in-lb with a stress of 350 psi (negligible), and a bending moment of $10N_1 = 16{,}220{,}000$ in-lb giving a stress of 11,750 psi.

The center section of roll body (A) carries half t "bite" torque plus $T_{fn1} = 3{,}457{,}500$ plus $971{,}000 = 4{,}428{,}500$ in-lb which for "new" and "old", $S_t = 11{,}640$ and 8400, gives the negligible stresses of 380 and 527 psi. For bending, the moment is readily established (without appreciable error due to slightly off center loading) from the formula for symmetrical load: $M = PL\ (1 + X) \div 8$, where X = the percentage or fraction of unloaded length. $X = (124 - 54.375) \div 124 = 0.56$ and $M = PL \div 5.12$ (compared to $\frac{PL}{4}$ for concentrated center load). $M = 2{,}980{,}000 \times 124 \div 5.12 = 72{,}300{,}000$ in-lb, which for "new" and "old", $S_b = 5820$ and 4200, gives stresses of 12,400 and 17,200 psi.

The prongs of the "fish-tail" on the driven end of the roll transmit the full torque of 8,700,000 in-lb. The diameter possible is limited by the minimum center to center of the rolls established for the mill, and for this

	Pass	Thick"	Wide"	Wgt. #	Area a"	Elong.	Long Ft.	HP. Hrs. per Ton Total	HP. Hrs. per Ton Pass	HP Secs. per Pass	Roll Ø"	R.P.M.	Feet per Min.	Feet per Sec.	Pass Secs.	Horse Power Motor Input	Horse Power From Motor	Horse Power To Rolls Total	Horse Power To Rolls Each
A Bloom-1	Ing.	24	26		552 av.		6.00										Motor Eff. 90%	Pinion Eff. 95%	
	5	20	23		460	1.20		0.95			A								
	6	17¾	23½	10,500	417	1.33	8.00	1.50	0.55	10,400	38¾	50	508	8.46	0.94	11,060	9,950	9,460	4730
	14	10	12		120	4.60		9.08			B								
	15	9	12¼		110	5.02	30.10	9.78	0.70	13,200	33	90	780	13.0	2.81	5,720	5,150	4870	2435
B Slab-2	Ing.	26	58		1350 av.		5.67												
		22	54	24,300	1188	1.14		0.70			A								
	Early	20⅝	54⅜		1120	1.21	6.85	1.00	0.30	13,100	38¾	50	508	8.46	0.81	16,200	14,600	13,850	6925
		8	54		432	3.12		6.52			A								
	Late	7¼	54		392	3.45	19.5	7.17	0.65	28,400	38¾	75	762	12.7	1.54	18,450	16,600	15,800	7900

		Bite: Amt. Off"	Bite: % Red	Bite: Ang. °	Bite: Length"	Bite: Area a"	Bite: Torque Arm"	Neck Friction: Coef.	Neck Friction: Rad."	Neck Friction: Torque "# in Terms of "P"	In Thousands: Total Torque "# (Each)	In Thousands: Bite Torque "#	In Thousands: Bite Roll Pres. "P" #	In Thousands: Bite #/a"	In Thousands: Bite #/in.w.	Neck Load: Each or Max. 1000 #'s	Neck Load: Effect. Brg. Area	Neck Load: #/a" Bearing	Comp. Rate: Amt. "Off" / T. x (Bite Secs.)
A	6	2¼	9.3	20	6.6	155	0.45L 3.0	.05	12	0.6P 990	5,950	3.0 P 4,960	1,652	10.7	70.5	N_2 826	460	1800	1.4
	15	1	8.3	14¼	4.1	50	1.84	.05	12	0.6P 419	1,705	1.84P 1,286	700	14	57	595	"	1290	3.3
B	Early	1⅜	5.6	15½	5.16	281	2.32	.05	12	0.6P 1,785	8,700	2.32P 6,915	2,980	10.6	54.8	1,358-N_2 1,622-N_1	"	3,530	1.1
	Late	3/4"	9.0	11⅓	3.81	206	1.72	.05	12	0.6P 1,720	6,640	1.72P 4,900	2,860	13.9	53.0	1,300-N_2 1,560-N_1	"	3,400	1.8

Figure 7 — Table showing calculations for the determination of forces and stresses set up in the rolling process.

case 34½ in. centers and 34 in. diameter. Determination of the width and projecting length of the prongs is a matter of general proportionment of the entire joint involving stresses in the spindle jaws. It is preferable that the spindle be stronger than the roll end, as the roll is the more "expendable" part.

Figure 9 depicts conditions of force application. Clearances are shown greatly exaggerated for pictorial effect.

Diagram (A) represents the initial stage, where contact surfaces are machined parallel, with pressure area concentrated at the extreme corners.

As the slippers wear, or if the slipper surfaces have purposely been slightly tapered in machining, condition (B) prevails. Since for any and even minute angular relative movement, the linear amount of this motion is greater at the periphery than toward the center (proportional to the radii), greater intensity of contact should exist toward the outer area. For example diagram (B_1) (referred to the center line) with maximum unit pressure f_o at the outside, and f_i, at the inside, possibly equal to zero. At a 2/3 ratio, the force (F) concentration is at a radius of 12⅞ in.

For this torque "couple", 8,700,000 in-lb, (F) = 338,000 lb applied to each prong.

Due to elasticity of members and wear, the local unit forces become more equal (per dot and dash lines) and (F) draws in to a lesser radius (r), thereby increasing its magnitude.

While theoretically some inequality probably prevails, f_o greater than f_i, in the final stabilization, it is safer to assume that uniform distribution is reached. In this case (see C_1) 10¾ in. becomes the minimum force radius and (F) is the maximum. Therefore, for this condition, stress in the prongs will be maximum. Then F = 405,000 lb.

This force applied to the prong as a cantilever at a distance of 7 in. from its base section x-x, 11½ in. deep by 12¼ in. average width, and having a modulus of $bh^2/6 = 270$, produces a stress of 10,500 psi.

With Figure 9 before us, it may be remarked in passing concerning the effect of undue clearances or "slack" between the contact surfaces. Realizing that this is a "reversing mill", driving contact is transferred to the opposite side at each reversal of rotation for each pass. While contact of respective surfaces is established prior to the actual bite of the rolls on the slab, or while the roll is free, the impact of the meeting surfaces due to the instantaneous acceleration of the roll mass to the driver speed at the end of its "slack" stroke is considerable. The impact is cushioned by the torsional resiliency or spring-like deflection of the long spindles. This repeated pounding, though not appreciably affecting the strength of parts, rapidly wears or pounds out

the slipper surfaces, and once undue slack exists, it grows at an increasing rate.

Rolls of this type are universally of alloy cast steel varying in alloying constituents, but generally running according to grade from 50/60 to 90/100 carbon and having, based on "near surface" test specimens, physicals respectively of from 105,000 psi ultimate, 48,000 psi yield, 9 per cent elongation and reduction, to 115,000/120,000 psi, 60,000 psi and 6 per cent average. Values particularly at the "cope" neck will be less.

"Fire cracking" of the surface due to rolling heat and water chilling, is a hazard to the roll strength.

Generous fillets at the necks and critical grooves are important to avoid concentration of stress. Bending stresses at any surface point alternate from plus to minus for each roll revolution, and you know what happens in bending a nail this way.

Design of pass grooves is a "specialty" and foreign to our consideration.

The *mill spindles* drive the rolls and therefore carry the same 8,700,000 in-lb each. For position, under the heaviest torque loads, the angularity is negligible. For the high edging passes with top spindle at near maximum angle, the rolling load and torque are relatively light.

Some men are confused thinking that a universal spindle will cause uneven rotation of the roll when acting at an angle. This is false as can be easily demonstrated. Provided the axes of the pinion and roll are parallel, though off-set, the roll rotates exactly in conformity with the pinion. The spindle itself will have an oscillatory rotation each revolution, but the speed difference caused at the pinion end is nullified by the reversed angularity at the roll end.

These spindles are made of a good grade of forged steel normally about 40/50 carbon, normalized and tempered showing about 80,000 psi tensile, 41,000 psi yield, 20 per cent elongation and 36 per cent reduction in area.

The upper spindle is carried, at its center of gravity, by a bearing with thrust collar, trunioned to the side beams of the "cradle". One end of the cradle is pivoted at the pinion stand, and the mill end is carried by depending links from an hydraulic cylinder mounted at the top of the housing and operated on the hydraulic balance system. The bottom spindle is similarly bearing supported in a spring loaded carrier.

The diameter of the "jaw" end, at the mill, is of course limited as for the roll.

The 19 in. diameter body section having a bending modulus of 686 and a torsional modulus of 1372 is subjected to a bending moment (due to spindle weight) of 1,374,000 in-lb, and the 8,700,000 in-lb torsional moment. Bending and torsional stresses are 2000 psi and 6330 psi or an equivalent combined of 6640 psi.

Referring to Figure 9, it will be noted that the force F = 405,000 lb is applied to the jaw in a considerably off-center, cantilever manner referred to any semicircular section of the jaw. Calculation of exact stresses would be very intricate and uncertain at that. The practical recourse is to figure as if centrally loaded, at say, a section made by a plane through the pivot center at 45 degrees. This definitely does not give the true stress, but figuring all spindles this way, experience has established the values of this false stress that will

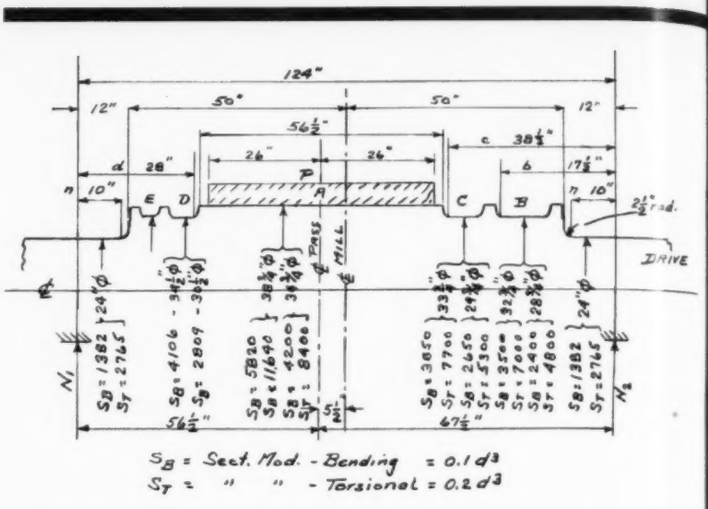


Figure 8 — Sketch showing the loading of the roll during a pass, and the section moduli for the various points in the roll.

afford proper strength. Slipper seat, and large radius fillet bores afford a strong jaw shape.

Due to the greater pinion center distance, the joint at the pinion can be, and is made larger for the obvious reason of insurance in strength and wear.

The construction of joint should be such that the slipper assembly remains in position to permit easy entrance of the roll fish-tail when roll changing. Particularly when a roll changing rig is used it is customary to jog the motor so that the fish-tails of the two rolls are in vertical alignment or horizontally parallel, before removing the rolls. The new rolls correspondingly positioned will then re-enter.

Control of the balance cylinder and of the provision made for moving the bottom spindle, permits a little juggling for position.

With any degree of spindle angularity, the surfaces of the fish-tail prongs move back and forth across the slipper faces and the slippers oscillate in their cylindrical jaw seats. This occurs under load.

Assuming the load F = 405,000 lb in condition C_1 of Figure 9, the contact area of 120 sq in gives an average bearing pressure of 3380 psi. The requirement for the slippers then is a material having good bearing qualities, together with ability to take a lot of impact. Typical of a good material is a special bronze having 120,000 psi ultimate tensile strength, 98,000 psi yield, 72,000 psi elastic limit, 13 per cent elongation, 15 per cent reduction, 250 Brinell.

The *lead spindle* may be the universal type, either short coupled, or long with carrier bearings, depending on position of the motor in the layout. If short coupled, some of the standard flexible couplings are well adapted. No space limitations restrict the diameter of the universal type, and so they can be generously proportioned.

Lubrication of all working surfaces is important. Application of grease through a system of holes, drilled in the jaws, connected to various designs of spring loaded cavities in the spindle body, is usual. In this particular case, a simple and very effective modification

is used. A steel casing enshrouds the tapered portion of the jaw hub and the contained oil is fed through the ducts by centrifugal force.

The *pinion stand* must withstand the overturning effect of the full and maximum torque of the motor. Mounted directly on ample, reinforced concrete foundation the base should have adequate spread, foundation bolts, and grouting ribs. The housing, having vertical flanged transverse central joint, has windows for the bearing fillings, and a bolted cap and end window covers complete the enclosure. Removal of the cap permits upward exit of the pinions.

The lead spindle neck of the bottom pinion takes the entire motor torque, and for our pass example, 18,340,000 in-lb based on 95 per cent efficiency of spindles and pinion stand. We assume the total torque or power "delivered" by the pinion stand to be equally divided to the spindles. Where (P) and (P_1) are the effective tooth forces (tangential to the 46 in. diameter pitch circles) of the top and bottom pinions respectively, on a torque or power basis, and assuming 97 per cent tooth efficiency, $P = 0.97P_1$. Referring to Figure 10: due to the involute pressure angle a, (22½ degrees) (P) and (P_1) are the horizontal components of the resultants (R) and (R_1). The vertical components (P tan a) and (P_1 tan a) are respectively the effective "separating" forces. Obviously the weight of the top pinion decreases the "lift" and the weight of the bottom pinion augments the "downward" force relative to "effective" values. The resultants of these effective verticals and the horizontals (P) and (P_1), become the total "top" and the total "bottom" bearing loads (R_t) and (R_b). For the 26 in. diameter necks and friction coefficient. (f), the frictional bearing torques are ($13R_tf$) and ($13R_bf$) respectively. The torque delivered by the top pinion teeth is 23P; and the "input" or retroactive torque of the bottom pinion teeth is $23P_1$, or 23.71P. Neglecting spindle efficiency, the top pinion tooth torque equals the sum of the top spindle torque and the top bearing torque. Therefore, to solve for (P) and thus establish bearing loads we have the equation:

$$23P = 8{,}700{,}000 + 13R_tf$$
$$= 8{,}700{,}000 + 13f\sqrt{P^2 + (0.414\,P - W_t)^2}.$$

This is a tedious computation for exactness. 8,700,000 ÷ 23 = 378,000 lb, so from inspection (P) will be in the neighborhood of 390,000 lb. With this assumption and for $W_t = 44{,}000$ lb top pinion weight, the net vertical component $(0.414P - W_t) = 117{,}000$ and by $\sqrt{\text{sum of squares}}$, $R_t = 407{,}000$ lb, or 104.3 per cent of (P). The greater the value of (P), the less is the influence of the weight and vice versa. $R_t = 1.043P$ is close enough for our purpose, and using f = .04, the top bearing friction torque is 13 x .04 x 1.043P = 0.543P in-lb, and then 23P = 8,700,000 plus 0.543P; and P = 388,000 lb. $R_t = 405{,}000$ lb equals top bearing load. Top pinion tooth torque equals 23P = 8,920,000 in-lb.

For the bottom pinion: tooth torque equals 23.71P = 9,200,000 in-lb and $P_1 = 400{,}000$ lb. Bearing load for bottom pinion and half coupling weight of $W_b = 65{,}000$ lb; $R_b = 461{,}000$ lb and bearing friction torque equals 240,000 in-lb.

The coupling input torque is the sum of the "bottom" torques of teeth, bearings and spindle or equals 9,200,000 plus 240,000 plus 8,700,000 = 18,140,000 in-

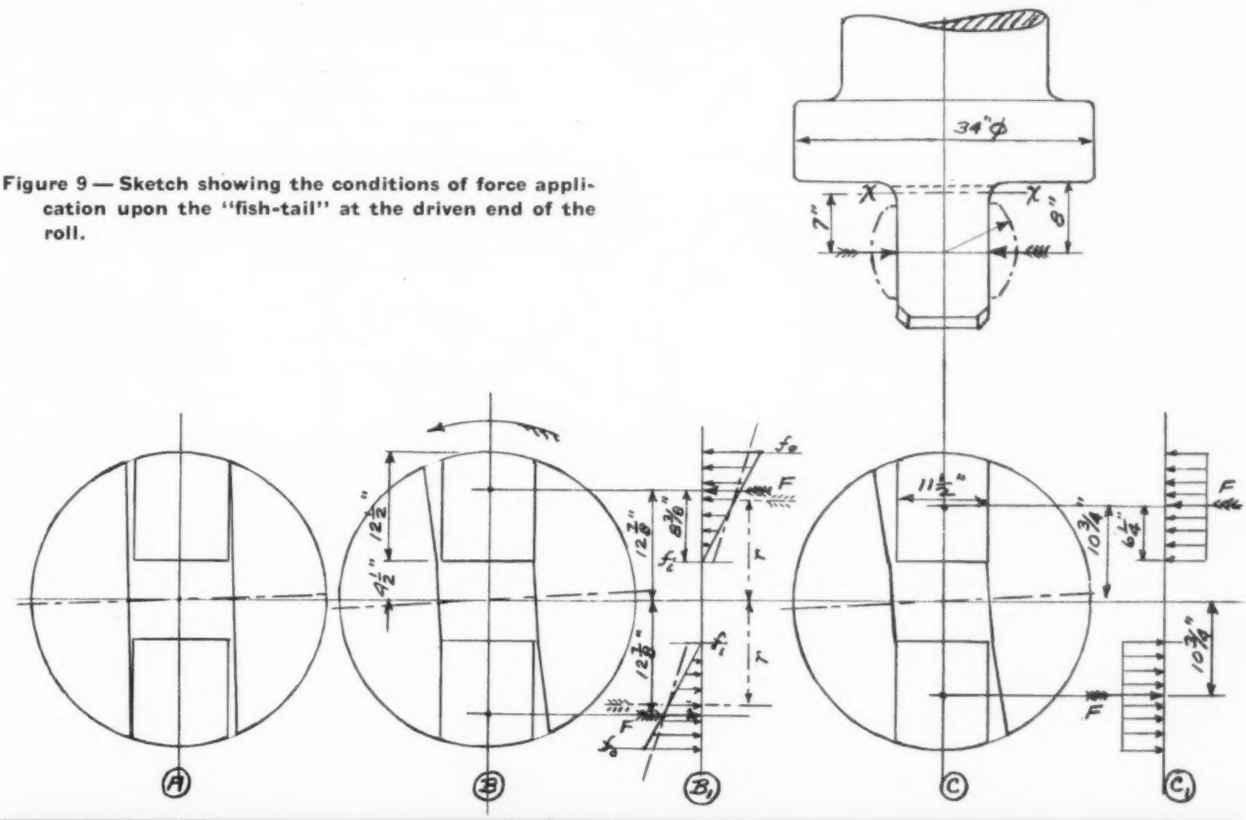


Figure 9 — Sketch showing the conditions of force application upon the "fish-tail" at the driven end of the roll.

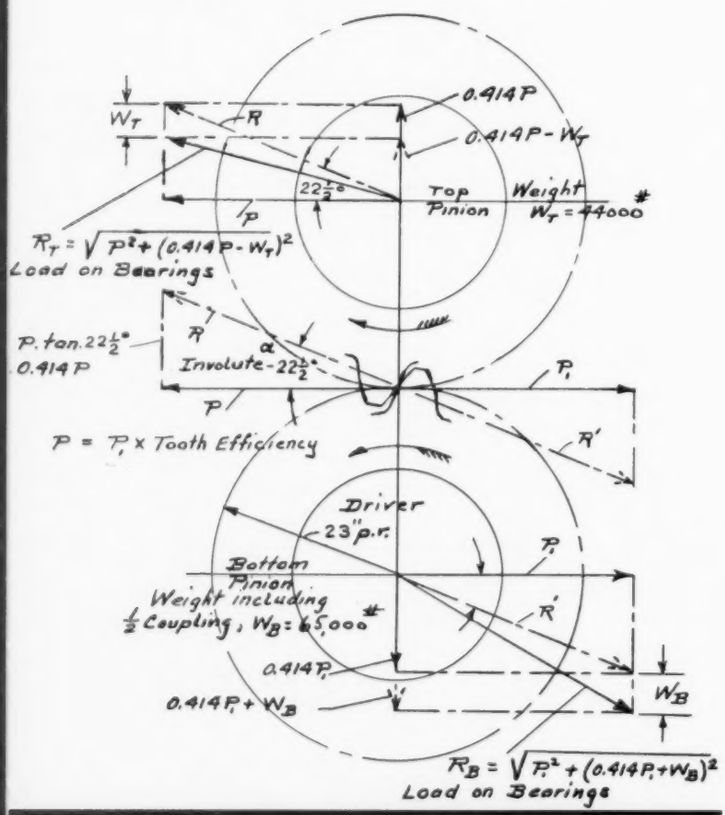
lb. Compared to the motor delivered torque of 18,340,000 in-lbs figured from the tabulated 14,600 hp at 50 rpm, it is evident that the 95 per cent assumed pinion stand efficiency is a little low. The 1 per cent error is negligible.

Due to the overhanging half coupling, the driving neck carries 50,000 lb of the (W_b), and 240,000 lb of the total (R_b) load, which on the 26 in. x 36 in. bearing having 880 sq in effective area, is 273 psi. With a bending moment of 4,320,000 in-lb and a torsional moment of 18,340,000 in-lb, with section moduli $S_b = 1758$ and $S_t = 3516$, the neck has stresses of 2460 psi and 5250 psi respectively. The other bearings and necks are more lightly loaded.

The pinions are alloy cast steel, having 23 double helical cut teeth and 50 in. face, and the 394,000 lb gives 7880 lb per inch face loading, and at 50 rpm a pitch velocity of 600 fpm, or 1440 fpm at 120 rpm. The bearing fillings are babbitted, with thrust surfaces. Single oiling (same for teeth and bearings) made possible by modern heavy lubricants is used. From a separate oiling system, oil is circulated through the bearings and sprayed on the teeth.

The *roll stand housings* are usually 25/35 carbon cast steel, annealed. Modern casting, shipping, and handling facilities permit single piece castings. These particular housings weigh 174,000 lb in the rough. Forged steel window liners to take the wear of the top roll chucks are usual. The posts of course are in tension, with tendency to be more highly stressed toward the window face. This particular housing has 34 in. x 17 in. normal post section or 578 sq in. The double section at the feed roll hole consists of 14 in. x 27 in. or 378 sq in between the hole and the window; and 24 in. x 8½ in. or 204 sq in beyond the hole, a total of 582 sq in. With the previous 1,622,000 lb neck load, divided for the two posts, the post load, 811,000 lb, shows an average tensile stress of 1400 psi for each section.

Figure 10 — Diagram of force loading upon the mill pinions.



The top and bottom ends should have ample depth and section moduli, to minimize a tendency due to deflection and the integral juncture with the vertical posts, to cause the latter to bow inwardly or to pinch the bearing chuck. This is of less importance in a blooming mill than a heavily stressed 4-high mill, as the top chuck does not travel when the housings are under load. Ample spread of "feet" and generous supporting surface on the shoes is important. Subjected to water and vibration, these surfaces sometimes wear or deteriorate astonishingly.

Roll neck bearings are usually babbitted with bronze inserts, and seat directly in the chucks with bottom and side seats. Lugs over bolts provide for endwise adjustment of the rolls for pass groove alignment. Fabric water lubricated shells are frequently used, instead of the babbitt linings. Automatic forced grease lubrication is normal.

Screws and boxes—15 in. diameter screw with single buttressed thread and 2 in. pitch has a load supporting area, (15 in. O.D. and 13 9/32 in. bore) of 41 sq in per thread or for full box length of 16 threads, 655 sq in. For an overbalance of 100 per cent or about 60,000 lb, the screws operate during adjusting travel under a load of 30,000 lb each or 47 psi. Neck load, for pass, 1,622,000 + 30,000 or total static load of 1,652,000 lb on assumed 75 per cent of threads in contact, or 490 sq in, registers 3380 psi.

The 12½ in. diameter dished step bearing, 122 sq in, carries 246 and 13,500 psi respectively. The box is drilled for feeding grease from an automatic grease system, to a partial length groove across the threads for thread lubrication. The step bearing is similarly lubricated.

Standard materials for screw and box and step bearing, are 50/60 carbon forged steel; nickel bronze running 45,000 psi tensile, 26,500 psi yield, 20,000 elastic limit, 12 per cent elongation, 87 Brinell; double heat treated aluminum bronze. Case hardened forged steel has been used for screws and boxes with reportedly increased life.

The *worm and worm gear rim* are usually forged steel SAE 2315 with teeth hardened and ground, and nickel bronze similar to the screw-box.

Double helical cut gears SAE 3140 forged steel are heat treated to around 275 Brinell.

All *screwdown bearings* are preferably roller bearings arranged for grease or oil lubrication. Gear teeth and worm wheel hub roller bearings are lubricated by circulating oil from a motor driven pumping system located on the screwdown platform. Complete enclosures with seals are mandatory.

In closing it may be remarked that in recent years no cast iron whatever is used in heavy equipment of this kind. Quite recently however, grades of alloy cast iron have been developed and it is conceivable that

they may find use, as a substitute for cast steel, for certain minor parts or where found applicable.

There is no limit to the detail into which one might go relative to the details of design of the thousand and one individual parts. This paper is not intended to be a "handbook of instructions" for the designer, but we trust that in touching on some of the high-spots, it has portrayed some of the features and problems involved in normal design.

DISCUSSION

PRESENTED BY

F. C. BIGGERT, JR., Chairman of the Board, United Engineering and Foundry Company, Pittsburgh, Pennsylvania.

LOUIS MOSES, Superintendent Rail Mill and Roll Department, Bethlehem Steel Company, Sparrows Point, Maryland.

C. P. HAMMOND, Superintendent, Steel and Billet Department, Atlas Steels, Limited, Ontario, Canada.

H. H. TALBOT, Senior Engineer, United Engineering and Foundry Company, Pittsburgh, Pennsylvania.

F. C. BIGGERT: Undoubtedly, the irregularities found in early power tests on blooming mills were very largely due to bearings, because at that time bearings on blooming mills were a pretty rough job of design. They were badly lined and usually had some brass strips inserted to help support the load, but there was very little attention given to protecting from scale and dirt, and they were lubricated intermittently when they happened to notice they were dry.

Recently bearings have been better protected and better lubricated. That has made a good deal of difference in the use of bearings. Fabric bearings and synthetic fabric impregnated bearings have been satisfactory in some instances. I am not too familiar with the results on that.

There is now being built a large slabbing mill in which roller bearings are being used. Of course, that is the ultimate answer. A roller bearing has stood up very well on some large plate mills, and there is no reason why it shouldn't do well on a blooming mill or slab mill. It will probably show a good bearing cost, although the first installation is very high.

The effect of the bearings on blooming mills and slabbing mills is not nearly so great as it is in the strip mills. Today in strip mill practice it would be impossible to use the old type of open bearings because the frictional load would run in some cases over half the total input load of the motor. With thick material, such as blooms and slabs, it is not so important, but it still is sufficiently important that attention should be given continuously to having the bearings properly protected and lubricated.

LOUIS MOSES: I would like to comment briefly on Mr. Talbot's mention of brass-stripped babbitted roll neck bearings. Combination brass and babbitt bearings, when lubricated by a grease system, can fail by reason of the differentials between the coefficients of friction and of expansion between the two metals. The brass inserts expand at a differing rate to the babbitt, particularly across their widths, with sufficient force to push up the adjacent walls of the babbitt. The action of the roll necks upon these very limited areas of babbitt simply peels the latter away with the accumulation plugging the grease grooves and inlets with certain and fatal results.

Babbitt linings have produced runs of over one million tons compared with 200,000 tons of product rolled on the brass and babbitt combination.

This comment does not extend to brass-stripped bearings which are run with packed hot-neck grease and water.

Another matter which might be mentioned concerns the allowance made in designing a new mill for total roll diameter reduction between new and discard sizes. High priced alloy rolls, often as not having an added investment of machined couplings, must make a return and without a full life expectancy the cost will be high if too little allowance is made. Discounting accidental failures the overall life of a set of blooming mill rolls depends upon groove side wear and the prevalence, or the absence, of fire cracking. With comparatively heavy diameter reductions sometimes required to restore groove widths fire cracking is always too deep to entirely cut away to clean metal. In the latter case recourse is had to cutting away enough surface metal to close up the cracks so far as possible to a non-damaging extent within the limits of reasonable individual dressings. Under either or both of these conditions the total amount of the range between new and discard diameters will permit or prevent a normal number of runs in the mill.

Such total diameter allowance should not be less than four inches for a 36 in. mill and five or six inches for a 44 in. mill. The surface metal of the modern roll displays good performance characteristics at such depths below new surface, measured radially.

In instances where inadequate allowance in this regard is made it may be assumed as a certainty that the new diameter will be promptly increased by the operators to obtain one or more added dressings. This increase over the originally specified roll diameter is only restricted by the total lift between new roll faces (in accommodating the highest ingot) and by the relative thickness of the bottom bearings (to position the top face of bottom roll with respect to bar climb).

Thereby all of the original calculations of bearing pressures, driving torques, motor characteristics, etc., go a glimmering to the dismay of the respective builders of mill and motor. With total roll reduction originally made adequate then these basically important calculations can be incorporated into the design. Any increased costs of mill construction should be weighed against the large sums periodically spent for rolls over the several decades during which such primary mills are usually operated.

C. P. HAMMOND: I would like to have an opinion in regard to the advantages of the hydraulic lift over the counterweights on the smaller type mills, under 40 inches, as to which is the most economical and what the advantages are.

H. H. TALBOT: I think the hydraulic system is

(*Please turn to page 67*)

A NEW *Soaking Pit Design*

. . . . of comparatively recent design, this soaking pit has found quick favor . . . . the action of the opposed burners offers a high degree of turbulence in the pit . . . .

by Joseph Sparks
SWINDELL-DRESSLER CORPORATION
PITTSBURGH, PENNSYLVANIA

▲ METALLURGICAL furnace designs have changed very much in the past few years. This is probably due to the increased demands made upon the quality and the quantity of the product. This cycle has brought about the changes in soaking pit design and operation. The continuous rolling process used in rolling mills has made large tonnage demands on soaking pits and the constant study of metallurgical engineers has caused topmost quality to be stressed very highly.

Many of the new type pits have proved highly successful in both quality and quantity, as well as showing remarkable profit to their owner. The newer pits have various shapes—round, square and rectangular. In one type, fuel enters the bottom and exhausts at either side; in another, the exit and inlet ports reverse at intervals, while in another, the fuel enters from each end and the waste gases leave in the same manner. This is the method used in the pit to be discussed in this paper.

The design of this pit has been made to give uniform heat distribution to both top and bottom of the ingot. The original layout was made with the thought in mind of sacrificing the pit-holding capacity if necessary, in order to provide sufficient combustion volume to burn all the fuel required, thus giving uniform heat distribution over the entire pit. Thus, we arrived at a pit which is fired by two burners directly opposed to each other in opposite end walls, with the burners located close to the bottom of the pit. It is always true, in the box-type pit, that the bottom is colder than the top unless provisions are made to concentrate the flame from the burners near the bottom of the pit.

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 10, '43

The design of the pits usually requires the space occupied by a four-hole regenerative pit block. In the normal regenerative pit design, we have a hole that is six or seven feet wide with a dividing wall that is approximately three feet wide. By taking the available space and removing the center wall, we are able to use the space that was occupied by the center wall as a firing aisle. Thus, we are able to get the same loading of ingots in the remaining space.

Figure 1 — Plan view of recuperative soaking pit in which the burners are directly opposed to each other.

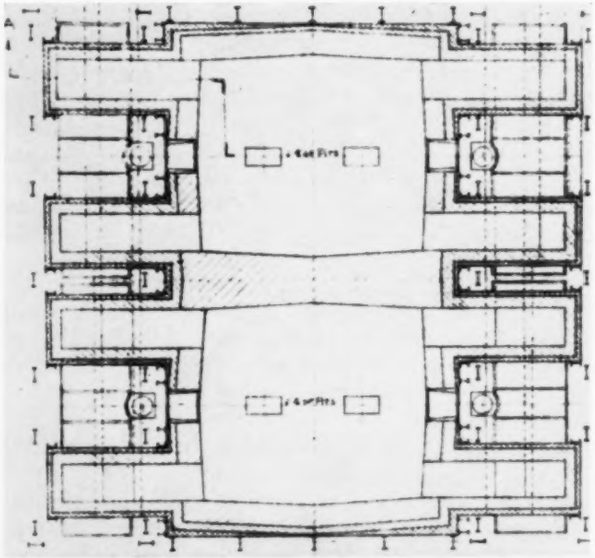


TABLE I

Soaking Pit Data

Heat No.	☐	☐	☐	☐	☐
Transit time hr-min.	2 –30	3–05	3–30	3–45	9–05
No. of ingots	10	10	9	8	9
Ingot size	31 x 56	30 x 40	30 x 48	30 x 48	28 x 57
Gross weight (tons)	134	119	114	105	146
Type of ingot	Hi. mag.	Killed	Bot. top	Bot. top	Cast case
Btu per ton heated	212,000	340,000	410,000	480,000	700,000
Tons per hour	44.6	30.8	29.2	26.0	15.8

Data of five consecutive heats.

After this was accomplished, it was found that the space occupied by the regenerators was greater than that required if the recuperators were to be installed on the pit, particularly if the recuperator was of the tubular silicon carbide design. A recuperator of this type can fit in very easily in an oversized flue passageway which leads from the pit to the stack. This allows extra available space in the regenerative pit layout for the lengthening of the pit furnace.

As the regenerative pit hole is approximately twelve feet long, it is not difficult to increase the pit size to seventeen or eighteen feet. We find that the recuperative pit furnace takes up no more available hearth space than the regenerative pit. A pit furnace which is fifteen feet wide by eighteen feet long can be loaded with a large number of ingots, uniformly distributed around the sides of the pit without over-crowding. This allows at least three sides of an ingot not only to be exposed to direct flame radiation, but to be exposed to the temperature from the combustion space in the pit.

As previously mentioned, the pit is fired in the two ends, the flames being parallel to the hearth of the pit. These two flames meet in the middle of the pit directly opposed to each other and are forced to the top and the side walls of the pit. They then travel along the back side of the ingots to the flue outlets which are located in the four corners of the pit. The gases then pass directly through the pit recuperator and thence to the stack.

The application of the silicon carbide recuperator to the pit is made to give sufficient air recuperation, or air preheat, for reducing the waste gas temperature to a temperature which is easily handled by the stack damper and flue brickwork without damage. In this pit design, no attempt is made to obtain excessively preheated air.

The recuperator is of moderate area, sufficient to maintain approximately 1,000 degrees of air preheat temperature. In supplying air to the pit, a cold-air fan is selected to blow air through the recuperator to the burner. This system has advantages in that the cold-air fan is no maintenance problem. Supplying cold air to the recuperator makes a reasonable physical layout without over-crowding the equipment. One fan is applied to each row of pits supplying air to the recuperator at a pressure of about one inch water at maximum flow.

This system of forcing the air through the recuperator under pressure allows us to measure the combustion air under standard conditions. We find the measurement is not affected by this variation in preheated air temperature such as would happen if the air were drawn through the recuperator with a suction type fan and then delivered to the burner.

The selection of the recuperator and the method of supplying air is dependent to a great extent on the selection of the burner itself. A burner in this pit can-

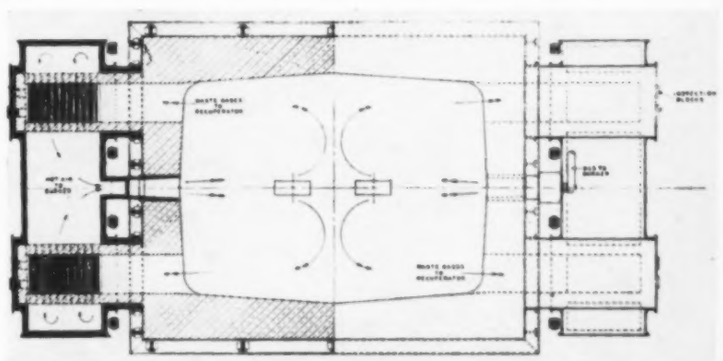
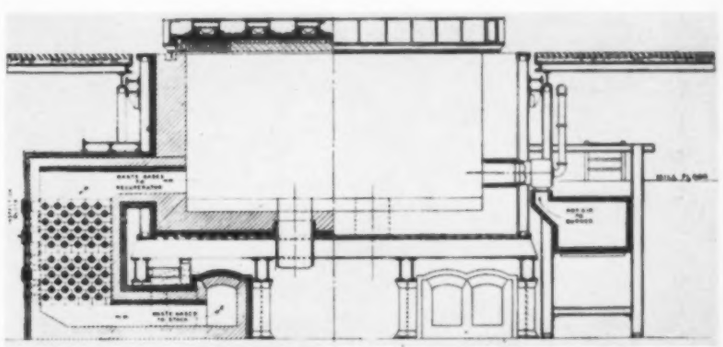
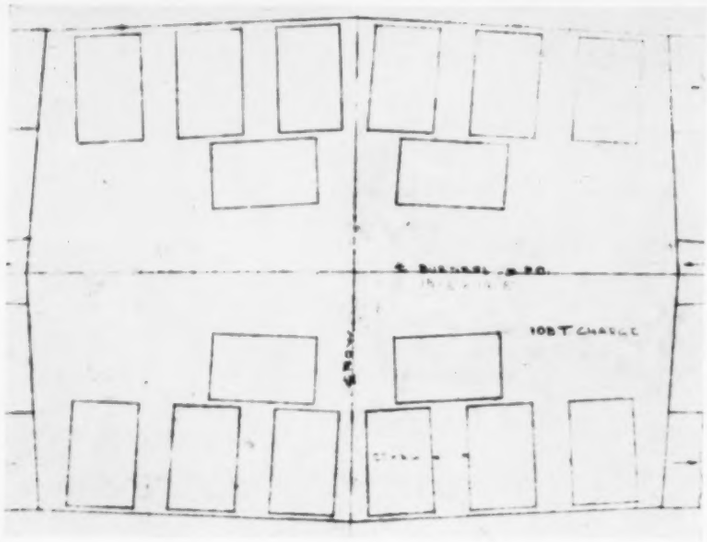
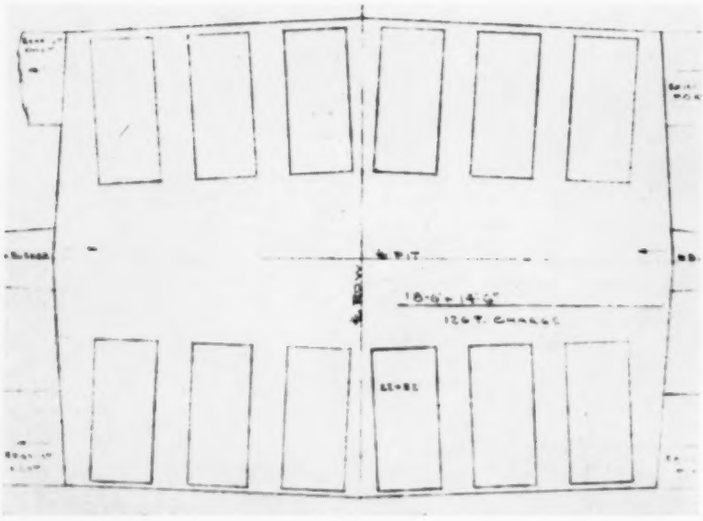


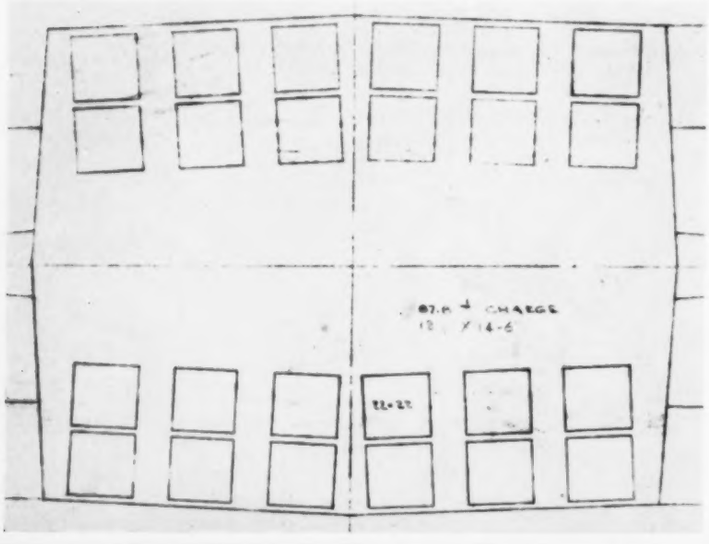
Figure 2 — Air flow and gas flow follow the paths indicated by the arrows in this plan view.

Figure 3 — Cross-section showing the general arrangement of pit and recuperator.









not offer large restriction to the flow of air from the recuperator to the pits. Nevertheless, the burner must be of a construction which will give uniform air velocity to the burner port so that proper mixing can be obtained.

We have found that the rate of mixing with preheated air is a very important factor in obtaining uniform pit temperature. This temperature is not only uniform at the top and bottom of the ingot but is uniform with regard to the corners and length of the firing aisle.

It is necessary in this particular pit to have uniform temperatures from the burner to the middle of the pit and also to prevent any localized hot spots. Close observation of our design indicates that extreme localized hot spots might be expected in the center of the pit at the point where the two flames meet. But after some experimentation on burner designs, we have developed a burner which gives uniform temperature of all ingots from the middle of the pit back to the corner. In making our original setup on the pit operation, we found that it was possible to get the center of the pit too hot. By making other adjustments, we found that it was possible to overheat the ports and ingots. But by careful selection and study, we now have pits under operation which give us uniform heat of ingots entirely throughout the heating cycle. These heats are uniform top and bottom and are uniform in regard to the ingot location.

The application of the controls to the pit is made very much in the conventional manner. As you know, pits are controlled by a combustion ratio regulator which adjusts the air flow in volumetric proportions to the flow of fuel. The stack damper is adjusted by a furnace pressure regulator to maintain constant pit pressure. The temperature control is installed and the pit temperature is measured by the insertion of two thermocouples in the side wall of the pit which is in close proximity to the top of the ingots.

In this design, we believe temperature control is the most important control item and every effort is made to obtain steel temperature in measuring pit temperature. What we actually get is a compromise between pit temperature and steel temperature. We fully realize that if a reading of actual steel temperature could be obtained, a faster operating pit could be had.

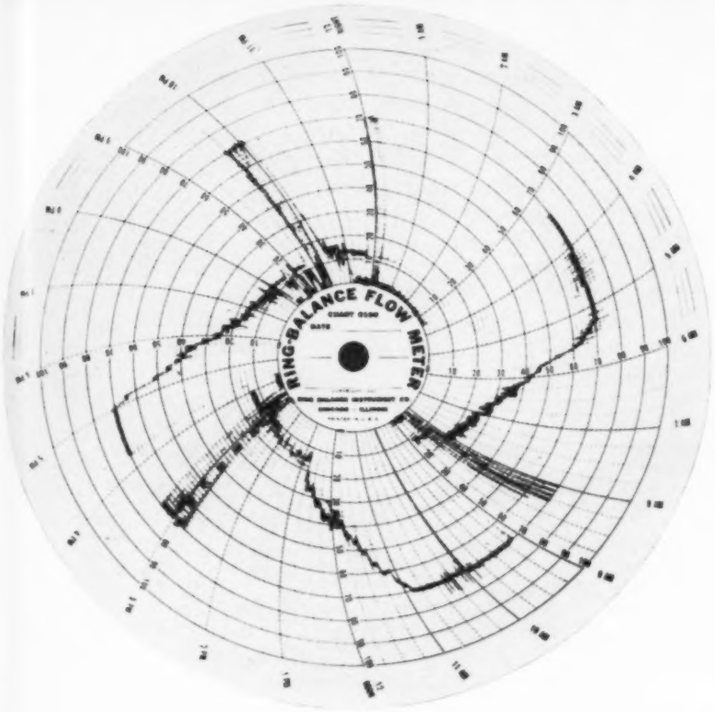
Many experiments have been carried out to determine the proper location of these thermocouples. Not only were we determined to find a location which was not susceptible to breakage caused by the loading of ingots, but one which would give us an accurate control of our temperature.

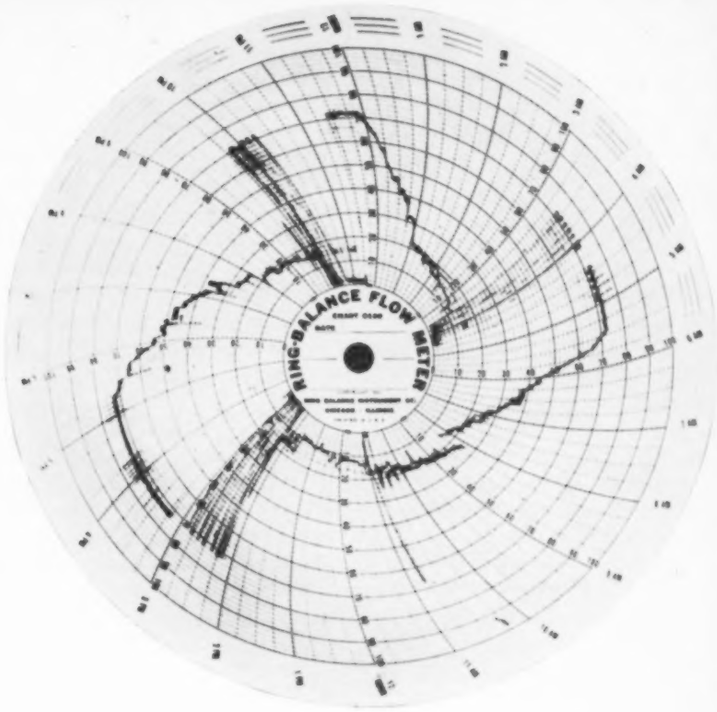
As a result of these experiments, we now find the temperature measuring element to be installed in a recess in the side wall rather close to the top of the ingot. Since the steel is heated uniformly at the top and bottom of the ingot, this point gives a close control

Figure 4 — (top) Charging plan of 18 ft 6 in. x 14 ft 6 in. pit, holding sixteen 22 x 36 in. ingots.

Figure 5 — (center) Charging plan of 18 ft 6 in. x 14 ft 6 in. pit, holding twelve 22 x 52 in. ingots.

Figure 6 — (bottom) Charging plan of 18 ft 6 in. x 14 ft 6 in. pit, holding twenty-four 22 x 22 in. ingots.

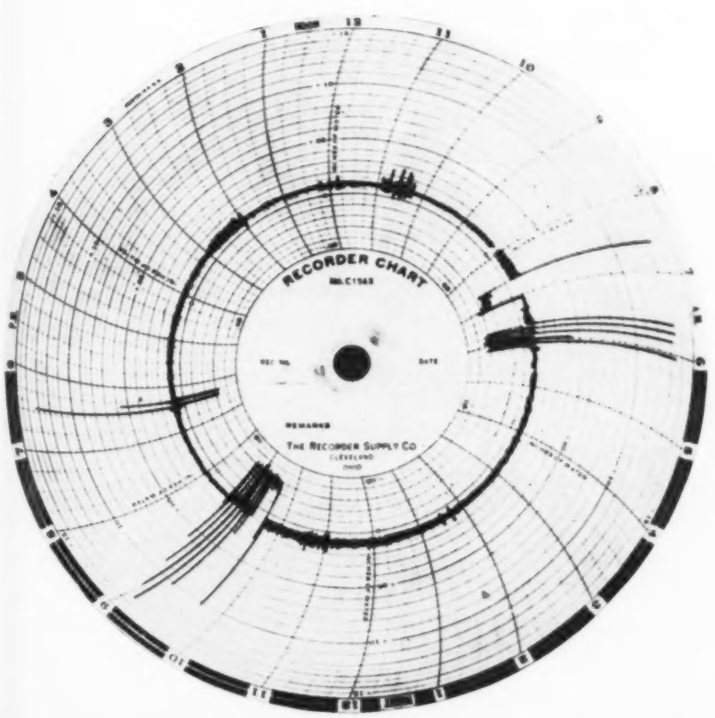




Figures 7 and 8 — Flow charts showing rapid fuel cut-off as steel approaches the desired temperature.

▲

Figures 9 and 10 — Furnace pressure charts showing the balanced pressure conditions maintained in the pit.



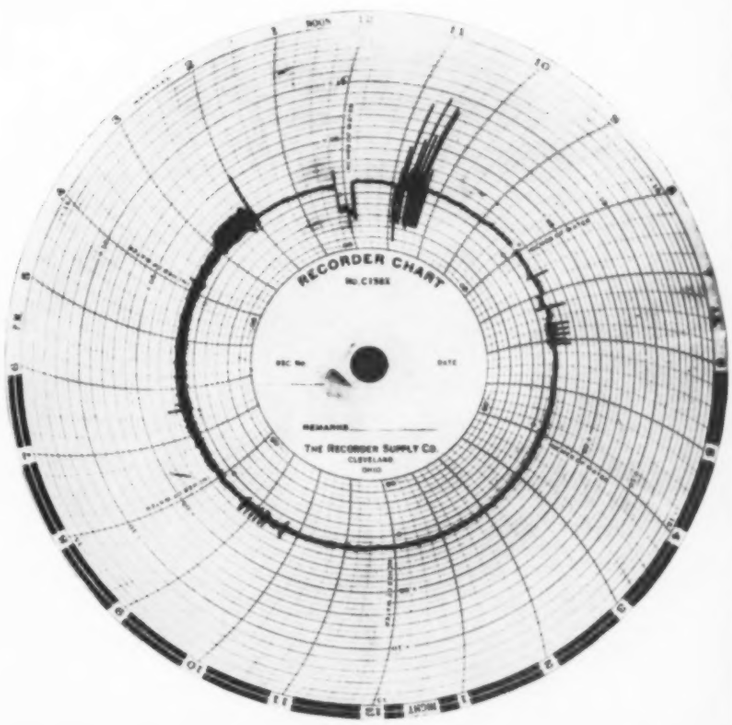


TABLE II

Monthly Fuel Report

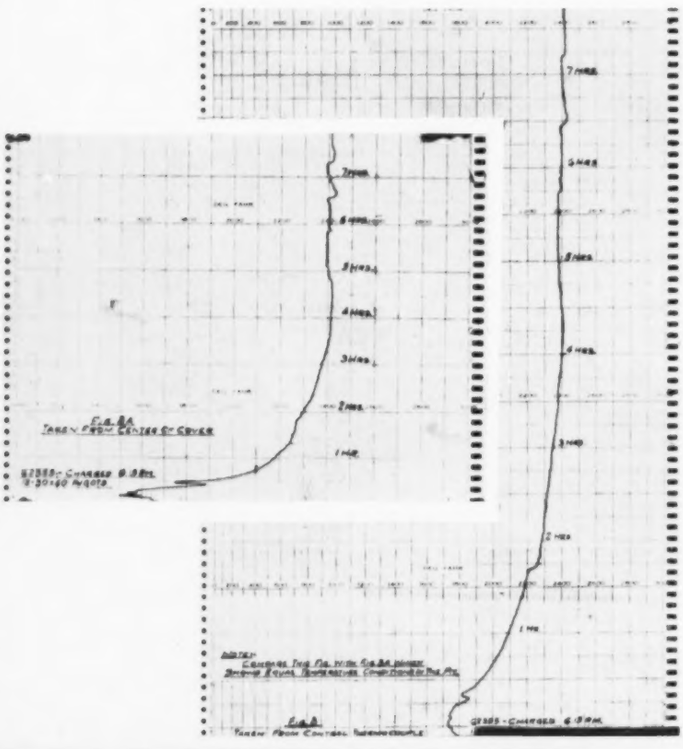
Row and hole	Tons of steel heated	Billions of Btu consumed	Btu per ton	Operating hours
A	10,265	4.358	425,000	744
B	10,241	4.756	464,000	744
C	9,804	4.212	430,000	670
D	9,980	3.761	377,000	666

of steel temperature. This factor is quite easily understood by reference to the control of gas flow with the relation to time.

In comparison of the gas flow on our pit with that on the normal recuperator pit, it has been noticed that the rate of fuel reduction is much greater with our pit than it is with practically any other type of recuperative design. This is the best indication of good pit performance which can be observed.

It is our contention that the ideal pit is the one which brings the surface temperature up to the rolling temperature, heating both the top and bottom and the back and front sides of the ingot at the same time.

Figure 11 — Temperature charts (left) from center of cover and (right) from control point near top of side wall.



If this is accomplished uniformly throughout the heating cycle, then very little soaking would be required.

The time of soaking required on an ingot is too long in most pits. The soaking of ingots is normally required to bring the bottom up to the top, not to bring the center equal to the outside ingot temperature. We wish to call your attention to the flow charts, Figures 7 and 8, which show the short soaking period that is required on the new pit.

The production from a pit is largely governed by two things: First, by the time required to obtain uniform temperature of the ingot at the top and bottom; second, by the time required to obtain uniform temperature of the various ingots with regard to their location in the pit. In many cases, the time required to accomplish this uniformity of temperature is two or three times the length of the actual heating period.

DISCUSSION

PRESENTED BY

J. L. MILLER, Assistant Chief Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio.

C. J. WYROUGH, Superintendent Steam Efficiency and Combustion, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

A. J. COCHRANE, Superintendent Plant No. 1, Bloom and Bar Mills, Inland Steel Company, East Chicago, Indiana.

B. C. WELLS, Superintendent, Blooming Mill, Republic Steel Corporation, Canton, Ohio.

R. A. LAMBERT, Combustion Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

JOSEPH SPARKS, Swindell-Dressler Corporation, Pittsburgh, Pennsylvania.

J. L. MILLER: I went to see a block of these pits shortly after they were installed. Difficulties at that time were being experienced in the balancing of the ends, and the proper burner elevations. The maintenance of thermal balance in the two distinct firing ends, I believed then and I still believe, will always be a mean adjustment problem for complete automatic controls.

From the data in the paper we do not know exactly what size holes and therefore what pit area you are discussing. The operators or fuel engineers who have worked with these pits could answer a great many questions to enlighten us, and we in turn then could use the information to advantage in our study of the relative merits of various designs. Your data would indicate about 350 tons per day on a mean of about 450,000 Btu for 3½ hour track time which is not exceptional when considering any other type of modern soaking pit installation for ordinary steels.

This is an interesting pit design — a double-fired, one-way recuperative soaking pit — but I feel the necessary data to nail down the advantageous claims made have not been set forth in this paper.

JOSEPH SPARKS: I would like to clear one point there. The tonnage I mentioned would be 700 tons per row of pits or 350 tons per hole.

You mentioned you had been in the Chicago area during the time we were having trouble balancing the pit. As you well know, this is a new pit design. We were in the infancy probably at the time you were there. The thing we had to do was raise the burner up from the bottom of the pit. We did this and we were able to balance the pit in a very successful manner.

I personally inserted the thermocouple in the center of the cover, and if the center of the pit doesn't vary any more than twelve to fourteen degrees, as the charts in Figure 11 show you, then I would be inclined to believe that the control problem is well in hand. After all, the hottest points to be expected in the design would be in the center of the pit. I think this chart will help you to see that we have very thoroughly covered that particular phase of operation.

J. L. MILLER: Are one of those charts from each end ?

JOSEPH SPARKS: No, these charts show the temperature of control thermocouples located in the side wall of the pit, in close proximity to the top of the ingots. The pit cover is of a flat arch design which has a two inch hole left in the center of the cover. The chart to the left shows the temperature taken from a portable instrument in which the couple was inserted in the center of the cover. The chart to the right shows the control temperature at the time we were controlling the heat.

If you will note, we have been able to eliminate hot spots which would have occurred in the center of this pit.

C. J. WYROUGH: Mr. Sparks stated that recuperator capacity applied to their pit is limited to that which will reduce stack gases to a temperature that will not damage the stack damper or flue brickwork. This indicates that a low preheat temperature is used and we would like to ask why, in the interest of fuel conservation, higher preheat temperatures were not used ?

The location of the four exhaust ports, one at the bottom of each corner of the pit, would mean that each port would have to exhaust the proper proportion of consumed gas to secure uniform heating of ingots. If, for any reason, any of the ports became blocked in any degree the tendency would be for the waste gas to exhaust through the ports which were more open and this would adversely affect the heating of the steel in the location of the blocked port. In our pits, which have but one exhaust port, trouble is sometimes experienced with slag accumulation in the port, which does not affect the operation of the pit except when the accumulation becomes excessive. In the pit discussed in the paper such an accumulation in any amount would appear to affect the operation of the pit.

JOSEPH SPARKS: I am glad the question was brought up about the thousand degrees preheat. I might have been misleading in the remark about the brickwork and recuperator. The recuperator could go on 1700 or 1800 degrees preheat, if you are willing to sacrifice that amount of fuel or heat which would go through the waste gas ports, and out into the stack.

Another point in the thousand degree preheat is, today we have many and various types of alloys which are heated in our pits. We have found with the low preheat we can reduce our flame temperature and thus heat alloy steel with the same ease that we can heat bottle tops, killed steel, or whatever. We make no discretion from one heat to another, regardless of whether it be alloy or the more common steel.

In regard to the waste gas ports clogging, the waste gas ports are approximately nine inches above the coke breeze. The waste gas port is constructed with an elevation carried upward. This problem of clogging is something we had never once thought of, but I assume that the engineer foresaw this possibility of clogging and eliminated it in his original design.

A. C. COCHRANE: I would like to know how they control the four flue out-takes while the pit is under a low firing cycle. It is not quite clear to me.

JOSEPH SPARKS: The way that it is taken care of is with an automatic furnace pressure controller. We have two dampers for each hole of a pit. Each hole has two dampers controlling each side of that pit. We are all familiar with automatic furnace pressure regulation. We have only one furnace pressure recorder on each particular hole of a pit. I think Figures 9 and 10 show you that we are not confronted with that trouble or we would have wide variations in range. As may be noted, we hold a very close range throughout the entire heating cycle; in fact, over a period of twenty-four hours. The reason for that is the fact that we have experimented with our furnace pressure atmospheric line and the line from the furnace until we have found a place where it works very efficiently. I think that more or less explains it. It is a good control arrangement. Does this answer your question and does the chart help you to see that we are not confronted with any trouble of the pit bucking itself ?

A. C. COCHRANE: It is not exactly the problem of the pit bucking. The point that is not clear to me is the condition during normal operations with low fuel input; that is, when the steel is practically up to rolling temperature, and you are holding. How are you able to control the stack draft so that one port will not rob the other three ? In other words, how can you prevent a short-circuiting of the exhaust fuel ? For instance, some of us have had the experience in the old type pits where we have had side flue out-takes. The tendency would be for the fuel to short-circuit toward the side of the pit. How do you prevent that in this pit ?

JOSEPH SPARKS: Assuming that the pit burners are located on the north and south sides, the north side of the pit pulls the fuel back to the north side, and the south side does the same. We have the damper for the north and south side of the pit as a single unit.

A. C. COCHRANE: Do you have individual dampers in each corner flue ?

JOSEPH SPARKS: No, our damper is a few feet from the stack, and it is tied. In other words, the south side is handled by one damper and the north side is handled by another. These are tied together in a common manner to be operated by one control cylinder, thus keeping the pit from going out of balance.

A. C. COCHRANE: From a practical standpoint, we all know when we charge the pit with ingots, we don't always charge them evenly; therefore, there is apt to be a restriction as far as the fuel circulating around

the ingots is concerned, to such an extent that it may have a tendency to restrict the flow into one corner port. How do you take care of that ?

JOSEPH SPARKS: That is an experience we have never been confronted with to any great degree. In fact, I can cite one operation where eleven ingots are charged in the pit, six are on one side and five on the other, and the furnace pressure regulator takes care of both sides very nicely.

The thing is, the automatic furnace pressure regulator has the human element taken out of it and acts instantly on an impulse taken from the pit.

A. C. COCHRANE: I would like to know about the adaptability of this pit to other fuels, oil or probably in an extreme case, blast furnace gas.

JOSEPH SPARKS: The pit is equipped with an oil burner which can be changed over instantly and which will handle oil very efficiently. But in regard to the blast furnace gas, I have had no experience in this pit; neither have I had any experience with oil. All I can assure you is that the burner which is part of our standard equipment on the pit is an oil burner made by a reputable manufacturer who is willing to guarantee us efficient results.

A. C. COCHRANE: In regard to the fuel performance, I notice you did state the hours. Does that Btu figure include all the down time on the pit as well as the operating time ?

JOSEPH SPARKS: As you recall, it was 744 hours. That is a 31-day month which consisted of down time, times when the mill was broken down and couldn't take the steel, and various things that might come up in the rolling mill later. That was an absolute tonnage figure based on the number of operating hours of the mill as a whole.

A. C. COCHRANE: In regard to the rapid cooling of the pit, in the case of alloy steels, how long does it take to cool a pit down for a special heat ?

JOSEPH SPARKS: I would suggest that it can be cooled amply within forty-five minutes by raising the cover up with a cover crane, then going away and leaving it, which leaves an opening of approximately six inches without doing too much damage to your brickwork.

B. C. WELLS: You made the statement that you made no differentiation between the heating rates of ordinary carbon steel and electric furnace alloy steels. I would like to know how that is accomplished.

JOSEPH SPARKS: As we know, we learn best by actual experience. We have an air preheat of approximately 1000 degrees, which in turn will lower our flame temperatures to a point where there is very little danger of burning alloy steels, and in this particular design there is no impingement on any of the ingots or any of the brickwork, by the flame, in any manner.

R. A. LAMBERT: In our one-way fired pits we cannot maintain the same pressure in the pit during the maximum flow as compared to turn-down. When we have very low fuel input during our soaking period, we find that we have to operate at a lower pit pressure. I notice by your charts that the same pit pressure is maintained throughout the entire heat. What I would like to know is, just exactly where do you locate your impulse pipe for your furnace pressure control and also does each pit have an individual furnace pressure control or do you have a control which operates the two dampers that you spoke of and also operates the whole section ?

JOSEPH SPARKS: Each hole has just one furnace pressure regulator. The impulse line is located directly above the burner on either side. It makes no difference.

R. A. LAMBERT: You don't mean in the cover ?

JOSEPH SPARKS: No, it is directly in the furnace wall, above the burner, where your furnace pressure line is installed. The damper on this particular design operates on a very close range. We are able to maintain constant furnace pressure by the fact of the closeness of the damper opening in the flue. We have never had to drop or raise the automatic furnace pressure in any manner. It has always conducted itself in the same manner.

R. A. LAMBERT: You have never had any smoking conditions during low fuel input due to carrying the same pressure as at maximum flow?

JOSEPH SPARKS: We have never experienced that, because our damper is very sensitive and has a very small opening. I think by the location of the damper that the anticipation might be just a little better than it is in some of the damper arrangements closer to the outlet ports.

J. L. MILLER: Do you imply that you have 100 per cent uniform gas flow in either end of the pit and maintain thermal balance in the pit over the steel heating and drawing cycle of operations?

JOSEPH SPARKS: Yes, I say that we do, because we have two flow meters on each particular hole. Those flow meters are taken off individual gas lines leading to the burner. Hence we have two automatic valves tied together, being controlled by one common mechanism, which in turn ties the two flows together to each burner.

If and when we were to go off on one burner — say, for example, we are burning 20,000 on one end and at the other one we slipped down to 18,000 — I assure you we would have an unbalanced pit condition. We have to keep the two burners firing with the same amount of fuel at all times, or else we are not able to operate with that degree of efficiency.

A. J. FISHER: I would like to have an expression from Mr. Sparks on how much of his fuel range is attributed to automatic control. For instance, if all the controls were taken off the pit, what, in his opinion, would be the percentage of fuel increase ? I am interested in that statement, because some of us have pits that are not automatically controlled.

JOSEPH SPARKS: The new type pit does need automatic controls. To be able to obtain a fair degree of efficiency on an old type pit, the automatic controls are needed more than on the new type pit. As we all know, the human element is removed by the use of automatic controls and carelessness is therefore eliminated. Still I cannot give you an exact percentage of the fuel increase. I would guess about 25 per cent.

Main Roll Drives FOR Blooming AND Slabbing Mills

. . . . the accumulation of experience with reversing drives has tended to standardize the methods of calculation, so that each application is no longer an individual experiment . . . .

by R. H. Wright

Westinghouse Electric & Manufacturing Company

EAST PITTSBURGH, PENNSYLVANIA

▲ THE history of electric blooming mill drives parallels the history of the electrification of the steel industry. Among the earliest main roll drives are three large induction motors purchased in 1906 to drive a blooming mill at the Gary Works. This mill consists of a tandem train of four two-high stands and one three-high stand. A reversing plate mill drive in 1907 was the forerunner of the modern reversing equipment in America and led to the installation of a reversing blooming mill drive at the Algoma Steel Company in 1911. Two years later two reversing blooming mill equipments were purchased: one by the Steel Company of Canada and one by the Bethlehem Steel Company. The Bethlehem equipment was therefore the first reversing blooming mill drive in the United States. A 34 in. mill drive at the Massillon Works of the Republic Steel Corporation was in operation at very nearly the same time. Most blooming and slabbing mills are reversing type, so the story of the reversing equipment is practically the complete story of main roll drive for blooming and slabbing mills.

At the time the pioneer electrical installations were made, there was little information to indicate what maximum tonnage could be expected from a motor driven blooming mill and what motor characteristics would be required to secure maximum output. The early electric mills were laid out to roll small ingots and the output usually was made up of small slabs and a mixture of bloom sizes. Of the initial electric blooming mill installations, only the tandem mill at Gary operated under conditions permitting tonnages comparable to modern practice. There was no hint of present day sizes and tonnages of slabs and there were very few slabbing mills.

The mills driven by the three pioneer reversing equipments are quite similar. However, because of the lack of application data, the motor characteristics are quite different. The base speeds vary over a range of almost 2 to 1; one being 75 rpm, another 70 rpm, and the third 40 rpm. The maximum torques likewise vary over about the same 2:1 range. All three of these equipments have double armature motors because design limitations of that time made it impossible to obtain the desired capacity in a single armature motor. Two generators are used and the motor and generator armatures are connected in series. All of these equipments are still in regular operation.

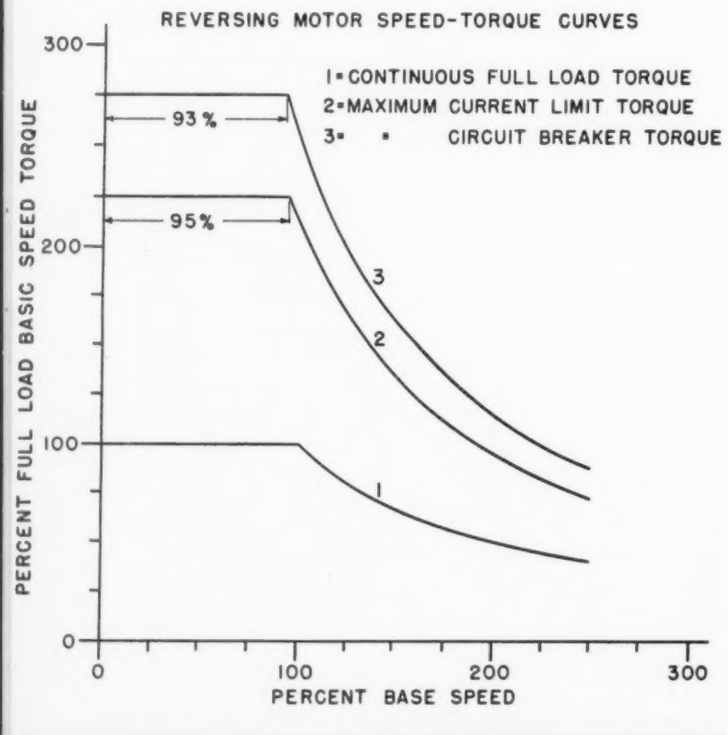
The ten year period from 1914 through 1924 was a period of development. During this time about 25 reversing blooming mill drives were installed for mills ranging in size from 28 in. to 45 in. Ingot sizes increased and rolling records were established which gave indications of the tonnage possibilities of each size of mill and the maximum requirements of the electrical equipment. Meanwhile electrical design improved and the continuous capacity and the maximum torque capacity of successive installations gradually increased. Practically all of the drives installed in this period had a base speed of 40 or 50 rpm in order to insure ample torque for heavy reductions in the roughing passes.

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 10, '43

By about 1924 the steel industry had practically standardized on two sizes of reversing equipments. One was a 7000 hp, 50/120 rpm drive with 2,000,000 pound feet maximum circuit breaker torque which was used for heavy 40 in. and 44 in. mills. The other rating was 3500 hp, 50/120 rpm, 1,000,000 pound-feet maximum circuit breaker torque, used for light 34 in. and 35 in. mills. Just at the end of the period, in 1924, the first 7000 hp single armature reversing motor was built. From this time on, single armature construction, except in special cases, has been used for all ratings.

In the ensuing years up to the present time the principal developments have been in design details and in providing greater capacity for heavier mills and unusual conditions. For example, two of the large steel companies found it necessary to install 54 in. blooming mills to provide beam blanks for some new beam mills. These mills were much larger and heavier than any which had been built before. The first of these mills was designed to roll 30,000 pound ingots. The motor is rated 8000 hp at 40/80 rpm. With the demand for heavier beams it was necessary to increase the weight of the ingots rolled in this mill. It became necessary to make reductions of over 100 square inches in some passes and motor torques went as high as 3,000,000 pound-feet, equivalent to 23,000 hp at 40 rpm. When plans were made for installing a duplicate mill it was decided to use a 10,000 hp, 40/80 rpm motor drive so that 50,000 pound ingots could be rolled. This requirement led to the development of the first twin-motor drive. A duplicate drive was installed the following year for the main rolls of a 44 in. universal slabbing mill. This was the first large universal slabbing mill.

Figure 1 — Standard relations between torque, speed and horsepower, as used in reversing motor drives, are indicated in this chart.



One of the recent problems of the industry has been the selection of new equipment for producing high tonnages of large slabs. It has usually been found desirable to have both the mill and the drive differ somewhat from conventional blooming mill equipment. Both universal slabbing mills and modified blooming mills, commonly called slabbing-blooming mills, have been used. To obtain high tonnages of slabs it is not necessary to operate at high speeds but it is necessary to exert heavy torques, so low speed, high capacity drives have been selected. For recent universal slabbing mills, 10,000 hp, 40/80 rpm twin-motors with 3,600,000 pound-feet maximum circuit breaker torque have been used for the main rolls. In two installations where the vertical rolls are in the main mill housing, the vertical roll drive is 3000 hp with maximum torque equivalent to 8250 hp. In another instance the vertical rolls are located at such a distance from the main housing that they do not synchronize with the horizontal rolls. In this case a 2000 hp drive has been used. One slabbing-blooming mill with a 7000 hp, 40/80 rpm drive has been in operation for several years and another is under construction. Another slabbing-blooming mill under construction will have a 7000 hp, 30/75 rpm twin-motor drive with maximum torque of 3,370,000 pound-feet. Another will have a 10,000 hp, 40/80 rpm twin-motor drive.

From the preceding review it will be evident that the accumulated experience is impressive and that equipment is now available for almost any set of conditions. The question naturally arises as to how this experience can best be utilized in the selection of new equipment or in checking the performance of existing equipment.

In past years rather elaborate calculations were often made of rolling time, tonnage and rms motor load, based on rolling schedules which were considered representative. Such detailed calculations can be quite accurate when applied to a fixed duty cycle, such as a mine hoist cycle in which the maximum load to be lifted, depth of shaft and desired cycle time are known within close limits. Detailed calculations based on reversing mill schedules may be very useful in indicating general performance but they are not an infallible guide in the selection of the drive. As is well known, the principal objection to basing the capacity of the drive on any set of rolling schedules is that it is often impossible to predict what a mill or drive may be required to do a few years after it has been installed. Other factors which are subject to change are the skill and temperament of the rollers, soaking pit capacity, grade of steel and ingot sizes. Because of these variables it has become the general practice to select drives which will do any work which the mill can reasonably be expected to do. The ratings which will match the performance of the various sizes and types of mills have been determined by accumulated experience.

The maximum draft which can be taken in a set of rolls of given diameter is determined by the maximum torque of the drive. The tonnage which can be rolled is related to the continuous horsepower rating and the base speed of the drive. For convenience and uniformity electrical manufacturers have set up certain standard relations between torque, speed and horse-

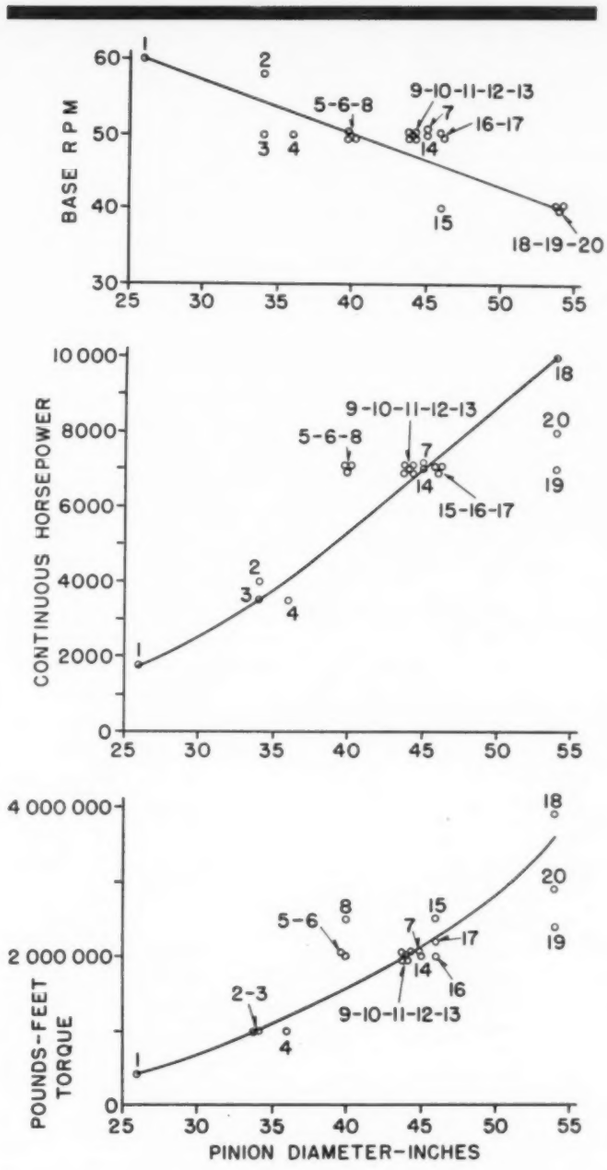


Figure 2 — Curves showing relations of torque, horsepower and base speed to mill size, as indicated by actual installations.

power. These relations, which are quite familiar to steel mill engineers, are shown in curve form in Figure 1. Also for convenience, continuous ratings are arranged in 250 hp steps from 1000 hp to 2500 hp inclusive, in 500 hp steps from 2500 hp to 6000 hp inclusive, and in 1000 hp steps from 6000 hp to 10,000 hp inclusive. Base speeds are available in steps of 5 rpm.

In this figure, the horsepower curves have been omitted for the sake of simplicity. The maximum circuit breaker torque at full field is 275 per cent of the rated full load torque and can be exerted from zero rpm to 93 per cent of base speed. This torque falls off with increasing speed above the base rating. The maximum full field torque corresponding to maximum current limit setting is 225 per cent of rated full load torque and can be exerted from zero rpm to 95 per cent of base speed. This torque likewise falls off with increasing speed.

If experience shows that a maximum full field circuit breaker torque of 2,000,000 pound-feet is required for a certain mill, the continuous full load torque is 2,000,000/2.75 or 727,000 pound-feet. At 50 rpm this corresponds to 6925 hp and a standard 7000 hp drive would be selected. At 40 rpm the corresponding continuous horsepower is 5540, and a 5500 hp drive would be used if mill conditions made it desirable to use a base speed of 40 rpm. The same reductions could be made with either drive but the tonnage output would be less with the 5500 hp drive.

The curves shown in this figure are a very convenient guide in the selection of reversing mill drives. They can be used to show the speed-torque characteristics of standard motors. Or, they may be constructed from rolling data to show what standard rating will be required to meet certain conditions. Assume for example, that the torque and final speed of a maximum pass are known and that the final speed is above the desirable base speed of the drive. The torque and final speed for such a pass may be plotted as a point on the current limit torque curve of the motor. A current limit torque curve can then be constructed which passes through this point. The curve can be extended back to the most desirable base speed thus giving the maximum current limit torque at base speed required to meet the given conditions. Using the fixed relations which have been standardized, the circuit breaker torque and full load torque can be calculated and the equivalent continuous rating of the equipment can be determined.

In order to indicate the general trend of American practice, the maximum circuit breaker torque, continuous horsepower and base speed of a number of representative blooming and slabbing mill installations are plotted against pinion diameter in Figure 2. The circuit breaker torque is shown in the bottom curve for pinion diameters ranging from 26 in. to 54 in. Beginning at 420,000 pound-feet for 26 in. pinion diameter, a curve of maximum circuit breaker torque at full field has been drawn through 1,000,000 pound-feet at 34 in. and 2,000,000 pound-feet at 44 in. to 3,600,000 pound-feet at 54 in. The continuous horsepower curve extends from 1750 hp at 25 in. pinion diameter, through 3500 hp at 34 in. and 7000 hp at 45 in. to 10,000 hp at 54 in. The base or full field speed ranges from 60 rpm for 26 in. pinion diameter to 40 rpm at 54 in. The curves in this figure are based on the installations listed in Table I.

While these curves are indicative of the general trend, naturally there are some exceptions to any set of such curves which can be drawn. For example, 7000 hp, 50 rpm drives have been applied to mills ranging from 40 in. to 46 in. In cases where heavy slabs make up a large part of the output, 7000 hp at 40 rpm has been used. Mills of 54 in. are operating with drives ranging from 7000 hp to 10,000 hp at 40 rpm. The latter rating may be considered as the maximum required to handle any work which can be done in a 54 in. mill under present conditions.

The preceding examples are representative of American experience. This experience is the chief factor in the selection of new equipment. However, cases arise

occasionally where it is reasonably certain that the tonnage to be rolled will never justify the installation of one of the standard equipments. Two alternatives are possible in such instances. Light drafts and more passes may be made, thus permitting the use of a smaller mill motor and motor-generator. This method of rolling would be particularly applicable to the production of blooms. Or, normal drafts may be made at lower speeds. This reduces the base speed and horsepower rating of the drive and permits the use of a smaller motor-generator. This will be especially satisfactory for slabbing work. To reach a decision as to which alternative to select, it may be desirable to make some calculations. These calculations need not be elaborate.

Obviously, the equipment must have sufficient torque capacity to make certain maximum reductions. In rolling blooms the maximum reduction and maximum torque requirement will come in the early passes just after the ingot has been squared up and before the section has been reduced materially. In slab rolling the maximum reduction may come at any time after the ingot has been rolled to width. When the heaviest reduction is made at or below the base speed of the motor, the rolling torque plus the allowance for acceleration and variations in the steel becomes the maximum current limit torque. This torque divided by 2.25 is the full load torque of a motor which will make the desired reduction. The full load torque multiplied by the base rpm and divided by 5250 is the continuous horsepower. The nearest standard rating is the minimum which can be used.

In some cases it may be quite certain that the final speed at the end of one of the maximum passes may reach a value above a desirable base speed for the drive. The point representing the torque and final speed for such a pass may be used in constructing a complete set of speed-torque curves as previously described. The nearest standard rating is the minimum which can be used. If this procedure gives a larger equipment than the mill tonnage will justify it will be necessary to reduce the maximum draft.

In general blooming mill practice, any drive selected in this manner will have sufficient continuous capacity for any tonnage which can be rolled with the selected maximum drafts. This is true because metal is in the rolls only 25 to 40 per cent of the total time and because some of the passes are light.

The most convenient way to determine the torque required for a desired maximum reduction is to observe the load on some other mill under similar conditions. Allowance should be made for any difference in roll diameter or base speed of the motor. The torque will be determined most accurately if the motor is operated with full field excitation during the test.

Where it is not convenient to make a direct check, the torques can be determined approximately by calculation. One method of calculation involves the use of curves similar to those in Figure 3. In these curves the horsepower seconds of energy at the motor shaft required to displace a cubic inch of metal are plotted against the percent of original area before the pass. That is, the cross section area of the ingot is 100 per cent and the per cent of original area for any pass is the area after the preceding pass, over the ingot area. The cubic inches displaced during the pass times the hp-sec per cubic inch at the proper percentage of original area is the total energy in hp-sec for the pass. At normal rolling speeds the torque is independent of the speed and can be calculated by using the formula:

$$T = \frac{\text{hp-sec} \times 275 \times \text{roll diameter in inches}}{\text{Length after pass in inches}}$$

TABLE I

Typical Blooming and Slabbing Mill Installations

1. Atlas Steel Ltd., Welland, Ontario
   26 in. blooming, 1750 hp, 60/150 rpm.
2. Republic Steel Corp., Buffalo, N. Y.
   34 in. blooming, 4000 hp, 58/120 rpm.
3. Kokomo Steel & Wire
   34 in. blooming, 3500 hp, 50/120 rpm.
4. Phoenix Iron Company
   36 in. blooming, 3500 hp, 50/120 rpm.
5. Republic Steel Corp., Gadsden, Ala.
   40 in. blooming, 7000 hp, 50/120 rpm.
6. Great Lakes Steel Company
   40 in. blooming, 7000 hp, 50/170 rpm.
7. Wheeling Steel Company
   45 in. slabbing, Horizontal Rolls, 7000 hp.
8. Bethlehem Steel Company, Sparrows Point, Md.
   40 in. slabbing, Horizontal Rolls, 7000 hp, 50/100 rpm.
9. Youngstown Sheet & Tube Company, Youngstown, Ohio
   44 in. blooming, 7000 hp, 50/120 rpm.

NOTE—Points on curves of Figure 2 corresponds to numbers on this list.

10. Steel Company of Canada
    44 in. blooming, 7000 hp, 50/100 rpm.
11. Carnegie-Illinois Steel Corporation, Homestead, Pa.
    44 in. blooming, 7000 hp, 50/120 rpm.
12. Ford Motor Company
    44 in. blooming, 7000 hp, 50/120 rpm.
13. Jones & Laughlin Steel Corporation
    44 in. blooming, 7000 hp, 50/120 rpm.
14. Tennessee Coal, Iron & R. R. Co.
    45 in. blooming, 7000 hp, 50/100 rpm.
15. Great Lakes Steel Corporation
    46 in. blooming, 7000 hp, 40/100 rpm.
16. Inland Steel Company
    46 in. blooming, 7000 hp, 50/120 rpm.
17. Bethlehem Steel Company, Sparrows Point, Md.
    46 in. blooming, 7000 hp, 50/100 rpm.
18. Carnegie-Illinois Steel Corp., South Chicago
    54 in. blooming, 10,000 hp, 40/80 rpm.
19. Bethlehem Steel Company, Buffalo, N. Y.
    54 in. blooming, 7000 hp, 40/80 rpm.
20. Carnegie-Illinois Steel Corp., Homestead, Pa.
    54 in. blooming, 8000 hp, 40 rpm.

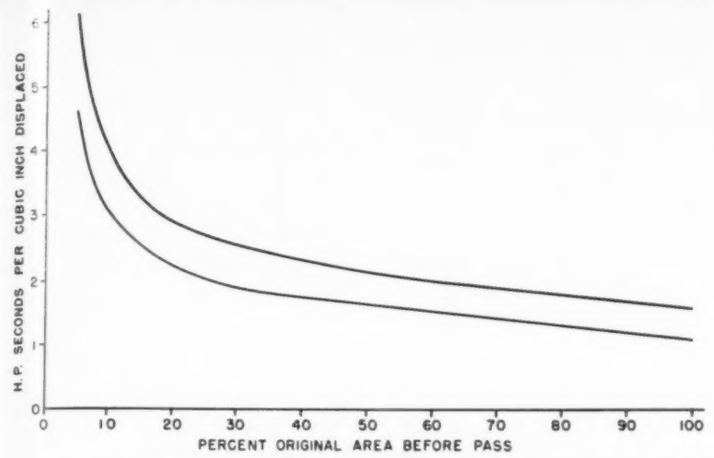


Figure 3 — Specific power consumption curves are used in calculating drive power requirements. Lower curve is for low carbon ingots, upper curve for high carbon and alloy ingots.

$$T = 275 \times \text{roll dia} \times (A_1 - A_2) \times \frac{A_2}{A_1} \times \text{hp-sec per cu in.}$$

Where A_1 = sq in. area before pass and A_2 = sq in. area after pass

The lower curve of Figure 3 is for large low carbon ingots and the upper curve is for small low carbon, high carbon and alloy ingots.

Another special problem is the selection of equipment to drive a secondary bloomer or billet mill. Such mills are installed occasionally to relieve the load on a 40 in. or 44 in. mill. Once a secondary mill is installed the tendency is to shift as much load as possible to it. This makes it desirable to have a drive with ample continuous capacity. Experience has shown that 4000 continuous hp is required to drive a secondary mill which follows a primary mill with a 7000 hp drive. The speed range is determined by the size of the finished section and the size of the bloom as received from the main mill. Usually a base speed of around 70 rpm is necessary to permit the secondary mill to keep up with the main mill.

Because of the nature of the load, most reversing blooming mill drives receive power from a flywheel motor-generator. For example, the output of a 7000 hp reversing motor operating at current limit setting is 14,980 hp. To supply such a load from a synchronous set it would be necessary to draw about 19,000 hp from the a-c system. At reversal such a peak might be followed by a regenerative peak of 3000 to 4000 hp, making the total change in load in less than one second as much as 23,000 hp. Most steel mill power systems will not stand such severe load swings, hence the use of flywheel sets for large drives operating with highly intermittent loads.

Some 15 or more reversing equipments ranging in capacity from 1250 to 8000 hp have been built with synchronous motor-generators. Some of these equipments drive small blooming mills and bar mills. Others drive structural mills and slow speed plate mills operating with such long passes that a flywheel would be of little benefit in equalizing peaks.

Some of these equipments operate quite satisfactorily with fixed excitation on the synchronous motor. Some half dozen others have automatic control to reduce voltage variations on the a-c system. With fixed excitation the kva swings are inherently less than the kilowatt swings, although the power factor may vary from near zero leading to unity. With automatic control of excitation the variations in power factor may be reduced and voltage regulation improved.

While synchronous motor-generators are not recommended for all blooming mill drives, there will always be some special cases where synchronous sets can be used to advantage. Application should be made only after careful study of all conditions.

BIBLIOGRAPHY

1. Shover — *Motors in Steel Mills.* A.I.E.E. Transactions Vol. XXVIII (1909), Page 101.
2. Sykes — *Electrically Driven Reversing Rolling Mills.* A.I.E.E. Transactions Vol. XXX (1911), Page 1587.
3. McCormick — *Electrification of a Reversing Mill of the Algoma Steel Company.* A.I.E.E. Transactions Vol. XXXI (1912), Page 645.
4. Sykes — *Power Requirements of Rolling Mills.* A.I.E.E. Transactions Vol. XXXI (1912), Page 2051.
5. Sykes and Hall — *Electric Drive for Reversing Rolling Mills.* A.I.E.E. Vol. XXXV (1916), Page 501.
6. Jefferies — *Operating Characteristics of an Electric Reversing Blooming Mill.* A.I.&S.E.E. Proceedings 1916, Page 309.
7. Petty — *Reversing Rolling Mills.* A.I.&S.E.E. Proceedings 1917, Page 361.
8. Wright, Davis and Needham — *Electrically Driven Reversing Mills.* A.I.&S.E.E. Proceedings 1924, Page 513.
9. Umansky — *Selection of Electric Drives for Reversing Mills.* A.I.&S.E.E. Proceedings 1925, Page 327.
10. Wright — *Modern Reversing Mill Drives.* A.I.&S.E.E. Proceedings 1929-30, Page 374.
11. Wright and Stokes — *Twin-Motor Drive.* A.I.&S.E.E. Proceedings 1931, Page 337.
12. Iverson — *Design of Modern Slabbing-Blooming Mills.* A.I.&S.E. Proceedings 1939, Page 12.
13. Sieger — *Hot Rolling of Blooms and Slabs.* A.I.&S.E. Proceedings 1939, Page 572.
14. Burt — *Reversing Drives for Slabbing Mills.* A.I.&S.E. Proceedings 1941, Page 225.

DISCUSSION

PRESENTED BY

G. E. STOLTZ, Manager, Metal Working Section, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

J. D. JONES, Chief Engineer, Youngstown Sheet & Tube Company, Youngstown, Ohio.

E. C. MARSHALL, Electrical Engineer, The Youngstown Sheet & Tube Company, Youngstown, Ohio.

R. H. WRIGHT, Steel Mill Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

W. A. PERRY, Superintendent Electrical and Power Department, Inland Steel Company, Indiana Harbor, Indiana.

G. E. Stoltz: It is of interest to review some of the very early experiences in the development of reversing equipments. I had an opportunity to look over the calculations that were made in selecting the reversing equipment for the universal plate mill at South Chicago plant of the Carnegie-Illinois Steel Company. This was the first reversing equipment built in this hemisphere. It was installed in 1905.

It was quite interesting to see their method of attack and their analysis of the selection of reversing equipment apparatus, where you have to determine the peak capacity that will be required for short periods, and that must not only include the power to roll the steel but also the accelerating torque required to accelerate the motor and the friction load. Then it is necessary to determine the continuous rating of the motor and the generator. The fly-wheel must absorb the peak loads so that the induction motor is only required to absorb the average load.

These calculations were made back in 1904, and while they are a little awkward as to procedure we would follow now, they necessarily were along the same lines.

There are the two or three very early equipments mentioned in Mr. Wright's paper: the Steel Company of Canada blooming mill, the Bethlehem Steel blooming mill and what was the Central Alloy Steel at Massillon, and is now the Republic Steel Corporation. They are all of about the same size mill.

The early installations were selected with too high full field speeds. I think the engineers were impressed with the rapid reversal obtained from a steam engine, and it was felt that it was necessary to have these motors operate at a high speed.

Experience taught us that increased tonnage on a blooming mill or reversing mill depends more on the auxiliaries, than on the main drive, and in general, if it is desirable to increase the tonnage output of the reversing mill, usually the operator will find that there is a better chance of increasing this tonnage by a careful study of his auxiliaries rather than the main drive. A slow speed has some advantage in that the operator has better control of the ingot and usually does not throw it as far from the mill. So in that respect, we had to change our ideas as far as the application of reversing drives to these mills.

Another thing that has been done is the application of devices that will limit the load. The early drives were designed to handle very high peaks, and not much attention was paid to the design to handle high continuous ratings.

The design of a motor to carry high peaks, but not particularly to carry a high continuous overload was satisfactory up to the time previous to World War I. However, during the war period the tonnage output of these mills was pressed very hard, as they naturally would be, and it was then found that by the application of relays that would control the operation of the reversing motor we could reverse our design; that is, design the motor with a high continuous rating and a lower peak rating. That did not mean that we necessarily limited the torque of the motor or the ability to take heavy drafts, but the relays put a ceiling on the peak that the motor would draw from its generator, and these peaks that disturbed us mostly were very often due to erratically controlled rates of acceleration or rates of retardation. By putting a relay on the reversing motor and limiting its value to some predetermined value, we could still take the same draft but would eliminate those very short, instantaneous peaks that meant little or nothing to the operation.

Rather than limit the output of the mill, these relays tended to increase its tonnage output. An operator, without the benefit of these relays, had to handle the motor in a way that the circuit breaker would not be tripped. These circuit breakers were arranged so that they had to be reset in the motor room. At first we gave the man in the pulpit a push button so he could immediately reset it, but we found he would be continuously tripping these breakers out and resetting them. If it was necessary to have the man in the motor room reset the breaker, the operator in the pulpit would be more careful to not trip the breaker.

Without the relays, the pulpit operator usually kept his motor capacity rather low. With the addition of the relays, he was able to push his master switch over to the full position and allow the motor to come right up to its ceiling, and the relays would allow the motor to operate at this ceiling throughout the pass, so that he actually got more speed than without the relays.

I think the future possibility of the electric drive, or its usefulness to the mill man, lies along two lines. One is a little more analysis or attention to the power requirements of electric drive. I think Mr. Wright has given you the impression, and rightly so, that if you install a forty inch or a forty-four inch mill and give us a little idea of what you are going to roll, we can immediately give you a quotation on the equipment that you require.

I think the reason for it is this. In the past, the power required to roll steel varied a great deal, and when we made tests on mills, we continued the tests for a week or two, because we found the results we got one day would not be repeated the next day or the third day. I think that the pressure you put on your bearings and the condition of your bearings had a great deal to do with the loads that were imposed on our motors. Now, with the improved design of bearings and mills, I think we get more consistent results.

The second point is that I think, as far as tonnage is concerned, results depend a great deal more on the time between passes rather than during the passes.

J. D. JONES: I recall that in the development of continuous ratings on motors for driving mills, particularly intermediate mills, when you asked your electrical engineers for something like that, they took you around to the different plants and showed you, with a great deal of pride, the ability of the motor to whittle an ingot down to a two by four in a couple of passes. That wasn't what we wanted. In other words, if they had gone back to the steam engine and hung around the governor, they would have found exactly what they wanted, which they subsequently did.

E. C. MARSHALL: There is little I can add to what has been so ably said, however a couple of questions arise in my mind. One is, who can predetermine what the steel mill ultimately wants or requires ?

I mention this particularly as a concern of the younger engineer, who is coming along and perhaps has in mind the making of an immediate product or several products, for which the relatively smaller blooming mill will suffice. However, later on he will probably find there is a demand for a greater number and quantity of products, to meet the newly built up trade and these will involve even greater loads on the blooming mill.

For that reason, I wonder if there can be incorporated in the main drive motor sufficient marginal allowance to permit of modification to handle the increased loads;

say within ten to fifteen years after the original installation.

The other thought pertains to the importance of the auxiliary drives and their proper selection, for it is my belief that in the operation of these auxiliaries about 40 per cent of the rolling time is utilized and this has considerable bearing upon the production of the mill.

Referring to the curves showing hp-hr per ton per cu in displacement, I ask the speaker whether or not the values include accelerating power.

RALPH WRIGHT: The modern reversing equipment, as it is now designed, is usually built to do just what it says on the name plate. If it is known beforehand that there is a possibility of heavier loads in the future, it is possible to put more material in the motor or make arrangements for using more generators or larger generators later on, or some other arrangement. In recent years, a number of devices have been resorted to, to increase capacity of old equipments. As Mr. Stoltz has said, the old equipments were designed for a maximum peak capacity with little regard to the continuous capacity. They would take any draft that anyone would want to take, but they would not roll as many tons as we would like to roll now.

As Mr. Marshall knows, it has been possible in many of the old installations to use a different slot design, repunch the old iron, or put in new iron, and get more copper in the machine, thus obtaining more continuous capacity, and still retaining the old peak capacity and still have good commutation.

We have been able in some cases, where an equipment has been selected for a certain base speed, say, 40 rpm, to raise the base speed to 50 rpm, merely by raising the voltage. When we raise the voltage, we have still maintained the same current, so we have increased the continuous capacity of the drive. I think that is the most fruitful arrangement probably for increasing capacity in the future. That usually requires new generators.

Almost any reversing equipment that is designed for one of the standard voltages will operate quite well under a higher voltage. This raises the base speed of the equipment. When you find you need more tonnage and the mill and drive will not stand any more draft, the best way to get more output is to raise the base speed of the motor. That has been done in a few cases in the last few years, sometimes without changing the generators, merely by increasing the generator excitation and raising the voltage. The results are always encouraging.

Of course, it is always possible, if you are sure that within the next few years you are going to need 8000 horsepower instead of 7000, to apply an 8000 horsepower equipment. Or the motor can be made oversize with the idea of changing the flywheel set later on.

Mr. Marshall's comment on the importance of the auxiliaries is very timely, and I think the trend toward the use of variable voltage auxiliaries is one of the best things that has been done in recent years to insure that the auxiliaries give the very maximum output of the entire mill.

Regarding the curves which were shown, those curves show a total energy required to displace a cubic inch of material. Acceleration has been taken out, and motor losses have been taken out, but the mill losses, which are always incidental to rolling work, have been left in, as they should be. So what the curves really represent is the output of the motor at the shaft, with all acceleration and electrical losses taken out. The mill losses are not eliminated because they are very difficult to separate and because we know they are a part of the motor job. Torque for acceleration can be calculated quite easily.

J. D. JONES: I think the development of our mill to the point of bringing our auxiliaries into step with the rest of the equipment is an important step. For instance, there is an important relation between the pits and the blooming mill, as there is between the pits and the open hearth. It happens that we are making an investigation of that now, and we have had some very interesting disclosures. Apparently these new pits that are going in are not going to do the job exactly, unless we fix up the auxiliaries; that is, with a little speed there and a little speed here, on receiving tables, etc. Getting them speeded up is all a matter of seconds, and in some cases split seconds, but it all counts up and means a great deal to us all. I think it is a subject which is worthy of continued development.

W. A. PERRY: My opinion of the drive on the blooming mill is not based on operating experience but is based on maintenance experience, and the operator of the mill may have an entirely different opinion. At one time the operator would like to have the motor running, let us say, at 80 rpm and drop the ingot or bloom a few inches from the mill for immediate re-entering. Shortly afterward he desires the bloom to leave the mill at a high speed in order to start it on its way to the shears.

I think, in all seriousness, a number of the mistakes made in the mills, especially on the main drives, are brought about by kicking around perhaps $25,000 or $50,000 on the original price of the mill. The designing engineers endeavor, with an array of higher mathematics, to show that the drive they intend to furnish will do all that the operating man would like to have done today. It would be better at the moment if they would forget a little of that approach and say, "We will spend an additional $25,000 or $50,000 and a few years from now this mill will be in a position to do something that you cannot anticipate today; and you will more than make up this expenditure in a relatively short period of operations."

Of course I realize that this is not the thing to do during a critical period such as we have today, when we are endeavoring to save all the materials we possibly can; but it is and should be a post-war plan that I think everyone should keep in mind.

G. E. STOLTZ: I would like to make one comment in regard to what Mr. Perry has said, and that is, if we are looking to the future, it is rather inexpensive to install reversing motors that are somewhat larger, if that is the thing they have in mind, than are now required, without hurting the design of the equipment for immediate use. The efficiency of these outfits over a pretty wide load range is flat. Assuming we need a 7000 horsepower motor and later may require an 8000 or 10,000 horsepower motor, an 8000 or 10,000 horsepower motor can be installed and operated at 7000 horsepower with approximately the same efficiency.

SCHEDULING THE *Primary Mills*

. . . . the scheduling of mill production must be fitted to the particular conditions in each plant . . . . the basic method, however, is practical, and may with modifications, be generally applied . . . .

by Alex Montgomery, Jr. AND *J. B. Holbrook*
CARNEGIE-ILLINOIS STEEL CORPORATION
DUQUESNE, PENNSYLVANIA

▲ THE subject of scheduling primary mills is a complex one, and to cover all details would require much time and many words. Therefore, the paper presents a method of scheduling based on the conditions surrounding the primary mills with which the authors are familiar. It is to be expected that some of the features will not apply to all mills. However, the basic principle can be applied to most primary mill operations.

To determine the method of scheduling to be developed it is first necessary to analyze for (1) product mix, i. e., range of sizes, sections, grades of steel, (2) the mill capacity, (3) the steel producing capacity, and (4) the flexibility permitted in steel provision.

After making this analysis, it is now necessary to design a scheduling system to fit our problem, and the organization is then developed to operate it. For the purpose of this paper, the layout as shown by Figure 1 is assumed, and you will note that two mills, one of which has three outlets, are fed by a common group of soaking pits. The sizes and sections rolled range from 1½ in. x 1½ in. billets to 12 in. x 12 in. blooms, slabs 4 in. x 2 in. to 20 in. x 4 in., as well as certain sizes of rounds, and standard sections. Various grades of carbon, alloy and stainless steels, both electric furnace and open hearth, are rolled.

Good planning is necessary to maintain maximum output on the mills. Experience has proven that under modern scheduling requirements, it is desirable to have a plant group with overall responsibility rather than one attached directly to one or another of the operating units to schedule the primary mills.

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 10, '43

On receipt of production order from sales division, a production planning department assumes responsibility for the interpretation and preparation of the primary mill production order (Figure 2), as well as the corresponding heat orders on the open hearth and electric furnaces.

To illustrate the method of planning to meet the conditions shown in Figure 1, we will describe the complete order flow of a customer's order which is to be rolled at the secondary mills from steel supplied by the primary mills. The particular order will be 3 in. billets, NE grade 8744, fine grain, .40 carbon, .75-1.00 manganese, .040 maximum phosphorus, .040 maximum sulphur, .20-.35 silicon, .40-.60 chromium and .20-.30 molybdenum.

The primary mill scheduling group of the production planning department receives this order for 56 tons and must then combine it with other orders of the same analysis, sufficient to make up a minimum heat lot which, in this case, we shall consider as 80 tons of ingots. In order to schedule these 80 tons of ingots to be rolled on the primary mills, the orders are combined and necessary information to produce them in the open hearth is recorded on a heat order card (Figure 3).

This heat order card No. 1558 is then delivered to the primary mills field planning division where a definite time schedule is set up for the melting and rolling of the heat. The man directly responsible for round-the-clock scheduling of the primary mills is known as the steel distributor, who coordinates furnace production with the primary mills rolling schedule.

A given combination of operating facilities has various limitations in capacity, size, range, etc., of its several units and the problem of the steel distributor increases or decreases accordingly.

In order to assist him in making decisions and controlling them after they are made, certain other personnel is provided. These men are stationed throughout the melt shops and primary mills and their functions will be shown as we trace the progress of heat order No. 1558 as previously described.

After furnace 114 has tapped and the furnace made ready for the next charge, the first helper reports to the open hearth weigh office and gives the weighmaster the predicted tapping time of the next heat. The weighmaster telephones this information to the furnace planning clerk, who assists the steel distributor in the field planning office. The steel distributor then places this heat in proper sequence for rolling on the primary mills.

In this particular case, let us consider that the 21 in. mill, for which this heat is scheduled, will be operating at least eight hours after the tapping of furnace 114 which will give the steel distributor sufficient time to schedule the heat. The furnace planning clerk then interprets this heat order in terms of furnace conditions which may or may not warrant the melting of an alloy heat. If everything is acceptable, the essential information on the heat order card is transmitted by

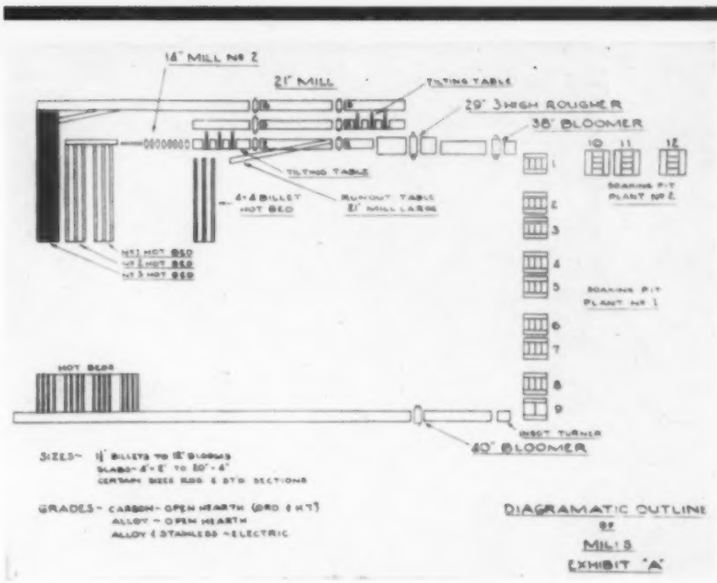


Figure 1 — Layout of primary and intermediate mills serving as an example for scheduling.

Figure 2 — Primary mill production order.

PRIMARY MILL
PRODUCTION ORDER

HEAT ORD 1558
OUR ORD NO VA-2267
TOTAL ITEMS
ENTRY DATE
FROM

CUST
SHIP TO 96 Mill
CUST. ORD NO. REQ. NO. DATE
HOW SHIP
SALE BASIS CUST SHIP REQ
PART AT
CREDIT
ROLL WK OF

SIZE 3 x 3
SECT. Billets
SPEC. WD-8745 of 57-107-D
PROD. CODE
FROM SHIP DATE
PM REQ. NO. 6064
MILL 6

C	Mn	P	S	Si	Ni	Cr	Mo
40/50	70/100	04	05	20/35	40/60	40/60	20/30
44	80	03M	03Max	25	50	50	23
41/48	70/100	04	04	20/35	40/60	40/60	20/30

GRAIN Fine
TYPE B2 Ni Cr Mo
COND. Hot Scarf-2
PURP. Operating slide USA 30 cal M-1 carbine fired not ht treated
INSP.
HEAT PROC. Ne 8744
PROV.
TESTS CHECK ANAL. D GRAIN ETCH D
QUAL STAMP Ingot # on ea pce Top cuts T-A-C Bottom cut B

ITEM	AMOUNT	LENGTH FEET	LENGTH INCHES	WEIGHT EA.-B. C.	WEIGHT EA.-A. C.	WEIGHT TOT. A. C.	SHORTS	RECUT TO	MULTS.	MERCHANT MILL SIZE & SECT.	MERCHANT MILL SET	MERCHANT MILL LENGTH
3	5b tons	30	0							1-5/16 Rds.		

CUT TEST: Pc | T_1 | M_1 | B_1 | T_2 | M_2 | B_2 | T_3 | M_3 | B_3 | T_4 | M_4 | B_4
HOW CUT.

MILL TOL Rating ISA
CMP-0-3-17 3/8/43

SPECIAL

MARK
STAMP
LOAD LIFT
SHIP IN ROUTE

PRIMARY MILL			TAPPED		DEOXIDATION PRACTICE AND/OR SPECIFICATION NO.	FURNACE	HEAT	HEAT ORDER NUMBER
ORDER NUMBER	MILL	SIZE	DATE	TIME				
5617 6064	21	3 x 3	4/5	7:30 P.M.	B-2-Ni-Cr-Mo			1558
PARTICULAR CUSTOMER			INGOT CODE			114	123	HEAT ORDER ISSUE DATE
			00-240 5061					4/1/43

PURPOSE	GRAIN	EL.	C	MN	P	S	SI	Nic	Cr	Mo
Carbine Slides	Fine	ORDER	44	80	Max 03	Max 03	25	50	50	25
		LADLE								

IND	TYPE MOLD	SIZE	WEIGHT	BLK	MILL	HEAT TONS	INGOTS NO.	INGOTS WEIGHT	SEMI-FINISHED DETAIL ORDER NO.	PCS.	BLOOMS — BILLETS SIZE	WEIGHT	LENGTH	CLASS
20	H-Tops	22 x 25	8550		21	80	2	8550	5617		3 x 3		30 ft	2
							18	"	6064		"		"	2

HEAT ORDER

SPECIAL INSTRUCTIONS

NE-8744
WA-8745

CMP-16

#1 only

Figure 3 — Heat order card.

teletype to the weigh office for the first helper and weighmaster and, at the same time, to the open hearth planning office for the floor recorder. The floor recorder interprets this information, removes a duplicate copy of the heat order which he has in his file and takes it to the individual furnace planning board. At the primary mill field planning office, the steel distributor then places a green copy of heat order No. 1558 in the hour slot predicted for the tapping of the furnace, which we will assume to be 1-2 P.M.

Figure 4 — The field planning division sets up a definite time schedule for melting and rolling the heat.

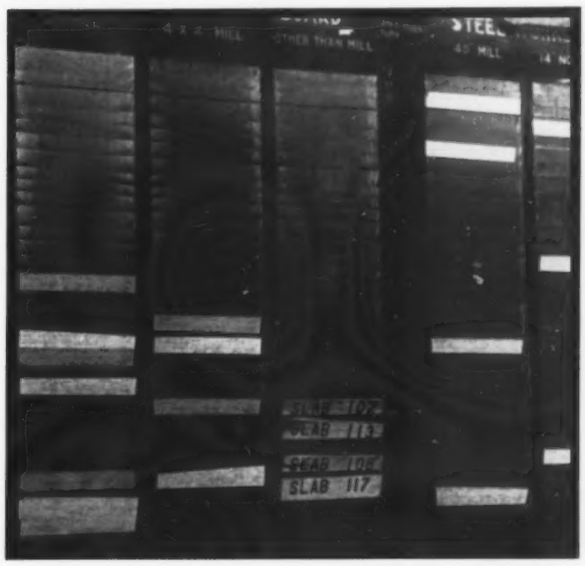
At the same time the furnace planning clerk does the following: (1) places two stapled copies of heat order No. 1558, a salmon and a white (salmon card showing), in the open hearth planning board (Figure 5) in the 1-2 P.M. slot; (2) assigns a set of hot top molds to this heat based upon its availability in the hot top mold cycle, which in practically every plant is a limited facility and is handled on the planning board between a twin set of availability and assigned tabs. The green heat order card which appears in the primary mill planning board then indicates to the steel distributor that he should have an open hearth heat comprising approximately 20 ingots tapping around 1:30 P.M. which should be available for rolling by 5:00 P.M. Changes in expected tapping time of furnace 114 are checked by hourly trips made by the floor recorder, whose report will show the furnace condition and expected tapping time of each furnace. Correct tapping time reporting is the basis for the planning and scheduling of all the operations in the primary mills.

The primary mill planning board is divided into the various major units of the primary mills, a panel for the 40 in. mill, a panel for the 21 in. large, the 21 in. small, and the 14 in.; and an additional outlet is provided for steel which is scheduled for delivery to other than the two primary mills. Therefore, at a glance, the steel distributor is able to picture the operations of the current and the two following turns on either mill based upon the cards that are showing and a running score of the total ingots scheduled. At the end of each mill rolling turn, the steel distributor then prepares a

Figure 5 — The open hearth planning board indicates the expected tapping times of the various heats.

summary report of the condition of the ingot supply available for the next turn's rolling. This is broken down into the available ingots which include those in the pits being heated and all those ingots representing heats which have been tapped, but which are not yet charged into the soaking pits. Added to this information from his panel board are those ingots representing heats which will tap on the present operating turn that can be rolled on the same turn. (Here field planning must be very careful to distinguish between hot top and ordinary ingots, since the hot top ingots take two to three hours longer in the tap-to-roll cycle.) On this same report, all other steel which has been scheduled for the mills and is still in the steel producing furnace, is shown as planned ingot production which will be the basis of scheduling succeeding turns. This particular heat order No. 1558, which is an alloy heat, has been ordered to be poured into 22 x 25 hot top, big-end-up, molds, each ingot to weigh 8550 lb. The furnace is reported tapped by the open hearth weigh office and the furnace planning clerk assigns a serial number to the heat for future identification; at the same time, removing from the open hearth board the salmon and white copies of the heat order, inserting the tapping information, and placing these two cards, (salmon card showing) in the slot where the duplicate green rolling card showed in the mill board (Figure 6). The green card is placed in the mail box for the 38 in. mill recorder which provides this man with preliminary data for his mill that he can then use to line up for the turn's rolling; and the salmon and white heat cards remain in the 1-2 P.M. slot until the heat is charged in the pits. The steel distributor in the meantime must receive information from the production planning department primary mill expediter who keeps him informed on pit conditions, mill rolling rate, and in addition, supervises the movement of the ingots from the stripper into the pits, reporting all these movements to the steel distributor. After the ingots are in the pits, the salmon card is removed from the rolling board and the white card is then placed in the hour slot during which the heat is most likely to be rolled on the mill.

The steel distributor, upon examination of any particular panel for any mill can summarize the turn operation by noting (1) the number of green cards which represent to him the potential supply of steel not tapped, (2) the salmon cards which indicate steel which is tapped but not yet charged and (3) the white cards,



Figures 6 and 7 — The primary mill planning board has a panel for each mill unit, and shows at a glance the operations for the next turns.

STEEL DISTRIBUTORS — ROLLING REPORT — 4/28/43

PREPARED BY Rusha — SCHEDULED AND ACTUAL — TIME PREPARED 7:00 A.M.

FOR McGrail — 38 MILL — FOR THE 7AM - 3PM TURN

INGOTS IN THE PITS AT 7:00 A.M. - 160

INGOTS TAPPED AND/PR COLD CHG. 11-7 TURN
TO BE ROLLED 7-3 TURN

HEAT NUMBER	INGOTS NO.	INGOTS CUML.	SIZE	GRADE
120093	21	21	2	A-8
128051	30	51	3	B-2

INGOTS IN PITS AT 7:00 AM = 160
INGOTS TAPPED FROM 11-7 TURN = 51
NO. INGOTS ACTUALLY AVAILABLE = 211
TAPPED 7-3 AND TURN
FOR ROLLING ON THE 7-3 TURN 86
TOTAL AVAILABLE FOR ROLLING ON THE 7-3 TURN = 297

EXPECTED ROLLING RATE 7-3 TURN = 285
BALANCE 3-11 TURN = 12
EXPECTED TO TAP 7-3 TURN AND 3-11 TURN FOR 3-11 TURN = 290
TOTAL AVAILABLE 3-11 TURN = 302
EXPECTED ROLLING RATE 3-11 TURN = 285
BALANCE FOR 11-7 TURN 17

INGOTS TO BE TAPPED — TURN

HEAT NUMBER	NO. INGS EST.	NO. INGS CML	SIZE	GRADE	TAP SCHED	TAP ACTUAL
115880	18	18	2	A-8	7-8	
112682	18	36	2	A-8	7-8	
126086	30	66	4	Spec A-8	9-10	
117268	20	86	4	MNB-2	8-9	
118314	20	20	2/3/4	MNSA-3	9-10	
116416	20	40	3	MNSB-2	10-11	
121583	30	70	2	SA-3	11-12	
124789	30	100	3	B-2	11-12	
130610	30	130	3	MNSB-2	12-1	
127440	30	160	3	C-1	12-1	
120094	20	180	4	A-8	2-3	
119413	20	200	5	MN B-2	2-3	
114123	20	220	3	B-2 NI,Cr,Mo	2-3	
123006	30	250	2	SA-3	4-5	
128052	30	280	4	Spec.A-8	5-6	

HOUR	CHG.	ROLLED HR.	ROLLED CUML	HOUR BAL	PIT CUM'L.
7-8	25	37		- 12	148
8-9	32	37	74	- 5	143
9-10	36	37	111	- 1	142
10-11	18	34	145	- 16	126
11-12	22	35	180	- 13	113
12-1	29	38	218	- 9	104
1-2	50	37	255	- 13	117
2-3	36	34	289	- 2	115

INGOTS IN PITS AT 7A.M. - 160
REMARKS

Figure 8 — Summarized rolling report for one turn showing ingot supply available for the next rolling turn.

steel which is in the pits to be rolled or being rolled. The particular heat order No. 1558 has now become heat 114123, and being an alloy heat, will require space reservation and special heating practice in the soaking pits.

The ladle analysis is carefully watched to note whether or not it finished within the ordered range. In case this heat was off in analysis, the 38 in. mill recorder would notify the steel distributor who in turn would arrange for a substitute order, or failing to receive one, must then change his planning so that this heat will be removed to the 40 in. mill pits where it will be bloomed down, cropped, and slow cooled. This loss of planned steel must be replaced either by shifting any excess ingots from the 40 in. mill pits or supplying additional steel by transferring a heat from furnace production which was scheduled to be sent outside the plant in ingot form, but which will be rescheduled on the next turn. This "other than mill panel of heats" is the cushion in the scheduling which allows for maximum flexibility. In other plants, bessemer production may be considered as this "cushion" in scheduling.

After heat 114123 is in the pits, the responsibility of the production planning department shifts to the mill recorder. From this point on, it is up to the mill recorder to schedule the operation of the various units to get the maximum production throughout the mills, based on the available supply of steel. The "on the spot" scheduling is handled by the recorder, but it must be borne in mind that accurate planning by the steel distributor is necessary 14-16 hours prior to rolling.

The actual scheduling of heats in the sequence just outlined is comparatively simple in principle, but it is the exceptions to regular operating procedure which cause the maximum trouble and it is through the use of the primary mill planning board and the experience of the steel distributor that departures from normal can be most quickly spotted and corrected. For example, if this heat order No. 1558 was scheduled to tap 1-2 P.M. and the mill was going to be down from 11:00 P.M. to 7:00 A.M., the ingots would have to be delivered quickly so that with good heating practice, they could be rolled during the 3-11 turn. If, prior to tapping time, this particular furnace should fall back 3-4 hours because of some operating difficulty, it would be unwise to allow the heat order to remain on the furnace because of the short time interval between tapping and the mill shutting down. Therefore, an order change would be made and most likely a "soft steel" (open top heat) would be ordered to replace this particular heat. The open top heat, if it tapped as late as 6:00 P.M., could still be rolled before 11:00 P.M. This type of order change is also used to meet varying rolling rates on the mills. In order to evenly control the "pit balance" the steel distributor uses the bottom portion of the ingot rolling report. At the start of the turn the primary mill expediter gives him an accurate count of all ingots charged in the soaking pits which are scheduled for rolling on the primary mill in question. Additional hourly information is obtained on the number of ingots charged into the pits (reported by the primary mill expediter) and the number of ingots rolled (reported by the pit recorder). The steel distributor, supplied with this information can then accurately determine his hourly pit balance. Sometimes it is necessary, for example, in the event of a breakdown of several hours, to stock the ingots prior to charging. If such a breakdown occurs and the steel is stocked, the heat order is withdrawn and the heating and rolling of the heat is rescheduled at a future date. Obviously this heat for 3 in. billets we have described must also be considered a part of the planned operation of the entire set of mill units. In other words this heat for 3 in. billets for the 21 in. small mill is one of many production items which must be integrated into a harmonious combination to provide a satisfactory overall schedule for all related mill units.

"Scheduling the Primary Mills" must be tailor-made to fit particular operating problems found at various plants. The procedure which has been described here will necessarily require modifications to suit the conditions of other plants, but the basic principle of schedul-

ing has proven practical, and is believed to be applicable generally, with satisfactory results.

DISCUSSION

PRESENTED BY

LOUIS MOSES, Superintendent Rail Mill and Roll Department, Bethlehem Steel Company, Sparrows Point, Maryland.

J. B. HOLBROOK, Assistant Superintendent of Production Planning, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

JOHN A. HAGAN, Superintendent Production Control, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

LOUIS MOSES: Do you find that your system of regulation is flexible enough to care for the hypothetical heat of steel when it goes astray of the time table? Delays in time of tapping, interruptions at strippers, filled up pits due to mill delays, etc., will occur and I wonder how the system cares for these.

J. B. HOLBROOK: That is a good question. I can best answer it by saying that in the planning board that we have set up here, the visual identification of each and every heat being planned — that is, through the charging, the tapping and the rolling — we have a very clear picture of the entire steel works.

I will try to answer your hypothetical question in a practical way. This particular heat, say, has had excess delivery time from the open hearth to the stripper. We get that information very readily from our primary mill expediter. If this heat will not be able to meet the rolling cycle, due to insufficient time for soaking in the pits, we must then replace it with this "scheduling cushion" that I spoke about, which corresponds to the bessemer heats in other plants. In our plant it happens to be "other-than-mill" heats. We must, temporarily, deprive our neighboring plants while we absorb the heat in quick time in order to supplant this loss in the ingot supply, and return the equivalent tonnage later on.

On an open hearth alloy or an electric furnace heat, we have a more difficult problem because the heat must get into the pits and necessarily certain pit capacity must be reserved regardless of the other steel at hand. This condition often causes the regular carbon steel to grow cold or be stocked. But nevertheless, the flexibility must be available there, and through this visual identification on the planning boards, we are able to maintain what I call a pretty good supply of steel for the primary mills.

JOHN A. HAGAN: I haven't a great deal to add, except to quote our experience at Youngstown. We know definitely that without plans and control operation in our intermediate mills, we haven't a chance of meeting our finishing mill schedules.

In the last two years perhaps it has been necessary for us to give a little more attention to what came out of the intermediate mill and when it came out. In meeting delivery schedules under priorities, our attention is directed even more toward that end.

I believe the system described in the paper makes a little more use of planning boards than we have used at our plant, but I believe in general, the approach to it is very similar to ours.

In the past two years we have been able to plan, and through control exercised at this particular point in our operation, we have reduced the number of times we miss a heat or miss a rolling to very much the exceptional case.

TALBOT *Discussion*

(Continued from page 47)

neater and easier to operate in roll changing. It has perhaps the disadvantage in the "upkeep" of the ordinary hydraulic system. It must be properly designed and given proper attention.

The counterweight system has been used on several fairly recent installations, and I think it has, for its chief argument, claims that there is less upkeep.

In the counterweight system, during roll changing, it is necessary to hook the counterweight in the "up" position in order to release the top roll. Therefore, it is necessary to have each top rider carried on a collar on the end of each screw, so that by lifting the screws, the riders are lifted clear of the roll.

The choice is a very controversial subject and one can go as far as he likes in arguing one way or the other.

STAMPING
MULTIPLE CHARACTERS
21677
with Matthews
Champion HOLDER
Made for hand stamping or press use... Matthews 'Champion' Holder can be used for 90% of all heavy or medium duty marking applications. Type changing is amazingly fast... marking is clean cut and in alignment. Write for Catalog 146-A for full particulars.
FOR HAND STAMPING
FOR STAMPING ROUNDS
FOR PRESS STAMPING
JAS. H. MATTHEWS & CO.
3982 Forbes Street Pittsburgh 13 Pa.
Branch Plants
New York, Boston, Chicago, Philadelphia, Newark, Syracuse
District Sales Offices
Cleveland Detroit Hartford Birmingham

Flakes AND THEIR Prevention

. . . . setting forth a cooling cycle for the prevention of flakes in alloy steels whereby time is saved and furnace work reduced . . . .

by O. A. Bamberger, MECHANICAL SUPERINTENDENT
REPUBLIC STEEL CORPORATION
MASSILLON, OHIO

▲ "FLAKES" is the name commonly applied to the internal cracks often found in special steels which have been subjected to hot rolling or forging. Their formation is particularly apt to occur in steels containing high manganese, nickel, chromium or molybdenum, although their occurrence is possible in almost any type.

Early views on the occurrence of flakes, which run independent of the grain boundaries, attributed them to stresses due to non-uniform cooling, to stresses set up during the deformation, or to transformation stresses, perhaps in connection with segregation, impurities or gases. Experiments, however, tended to discount these items as the basic cause.

REVIEW OF THE LITERATURE

Reviewing briefly the results of various investigations on the subject of flaking, it has been shown that flakes occur in steels of various composition; that the melting process exerts a certain influence, insofar as crucible steels, acid open hearth steels and acid high-frequency electric steels were less prone to flake than basic open hearth steels and basic electric furnace steels; that the tendency to flake increased with ingot size, with pouring temperature and velocity, and with ingot washes rich in hydrogen; that ingot bottoms displayed a lesser flaking tendency than the tops; that slow cooling and increased working tended to prevent flakes; that flakes formed depending on the velocity with which the temperature of about 400 F was passed in cooling down; and that flakes may be closed up by re-working.

Recognizing, however, that cracks can form from stress alone, experimental work followed the line of search for an element which could cause stresses exceeding the material strength at temperatures below the lower critical in the deformed piece, and which could be removed or converted by slow cooling to below 400 F. Gases dissolved in steel are not entirely liberated during solidification, part remaining in solution. During cooling, either because of diminished solubility or of dissociation of some compound, this gas is liberated, and if not able to diffuse out, may cause stresses. It was found that the addition of hydrogen to steel produced flaking at will, not merely in the susceptible steels, but in all types. Oxygen or nitrogen had no similar effect, merely producing blowholes. The fact that hydrogen present in hot steel becomes less and less soluble in the steel at sub-critical temperatures, with a notable drop in ability to diffuse out of the metal at about 500 F, answered the requirements stated above. This theory of hydrogen as the basic cause of flaking, with a temperature of formation of 400-500 F, has received strong support. Flakes have been produced in steel by treating molten steel with hydrogen and by heating steel bars to approximate rolling temperatures in an atmosphere of hydrogen.

An investigation of the relation between melting practice and flaking tendency indicated that scrap and pig heats seemed less susceptible to flakes than pig and ore heats, with a minimum susceptibility attained when the boil was 50-60 minutes with a carbon elimination of .50 per cent or more; that a prolongation of the refining period led to a susceptibility to flaking; and that the elimination of moisture from materials entering the furnace is desirable.

Through all of this literature, however, there is no conclusive statement as to the true cause of flakes, nor is there any positive method advanced for their prevention.

Presented before A. I. S. E. Annual Rolling Mill Conference, Pittsburgh, Pa., May 10, '43

TABLE I

Record of Tests to Establish Flake Prevention

Sample Number	#0	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Initial temp. °F. (end of forging)	1500	1500	1400	1500	1500	1500	1500	1500	1500	1400	1400	1425
Air cooled to temp. of, °F.	Room	1000	1000	1000	1000	1000	1000	1000	1000	....	....	....
Time of air cooling, hours	14	5	5	5	5	5	5	5	5	....	....	....
Soaked at temp. of, °F.	....	1000	1000	1000	1000	1000	1000	1000	1000	....	....	....
Time of soaking, hours	....	4	4	5	5	4	5	4	4	....	....	....
Reheated to temp. of, °F.	....	....	....	1500	1500	1500	1500	1500	1500	1500	1500	1500
Time of reheating, hours	....	....	....	5	5	6	5	5	5	5	4	5
Soaked at temp. of, °F.	....	....	....	1500	1500	1500	1500	1500	1500	1500	1500	1500
Time of soaking, hours	....	....	....	4	4	5	5	4	4	5	4	4
Furnace cooled to temp. of, °F.	....	....	Room	300	....	Room	500	800	1200	500	1000	....
Time of furnace cooling, hours	....	....	64	79	....	92	65	50	22	67	38	....
Air cooled to temp. of, °F.	....	Room	....	Room	Room	....	Room	Room	Room	Room	Room	Room
Time of air cooling, hours	....	5	....	2	11	....	5	5	7	4	8	11
Total cycle time, hours	14	14	73	100	30	112	90	73	47	80	54	20
Brinell hardness	402	364	340	187	241	187	202	187	179	269	269	387
Flake condition	Flaked badly	Flaked badly	Flaked badly	No flakes	No flakes	No flakes	No flakes	No flakes	No flakes	Flaked, not open	Flaked badly, not open	Flaked badly, not open

(All furnace cooling at rate of 15 degrees per hour.)

METHOD OF FLAKE PREVENTION

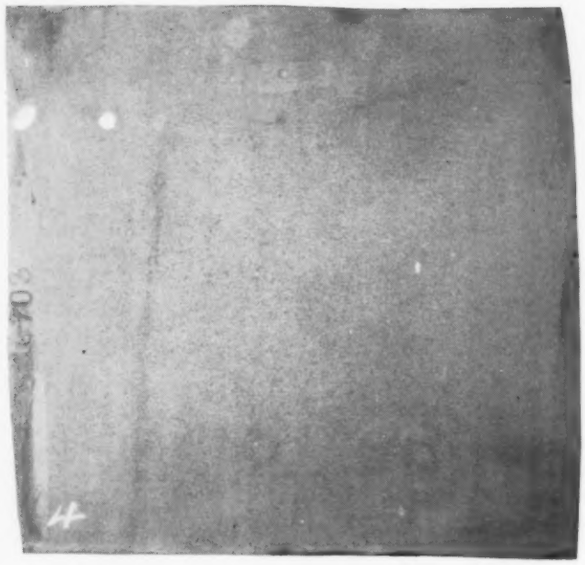
Any practical means of avoiding flakes cannot take much account of the composition of the steel or the methods of its manufacture. Regardless of these factors, the fact remains that it is up to the mill operators and mill metallurgists to prevent flaking. Precautionary measures have all involved some form of slow cooling with or without a soaking period, averaging from 10 hours cooling from 1500 to 375 F for small pieces, up to 100 hours cooling from 1600 to 200 F for large pieces. Many experiments have been run in an effort to find the proper cooling cycles for the avoidance of flakes, and many results (often contradictory) have been obtained. These precautionary measures, however, are not always successful, and in spite of all care, results are not positive. Furthermore, the length of the cooling period is such as to delay steel in process and to require a great amount of pit or furnace capacity for cooling.

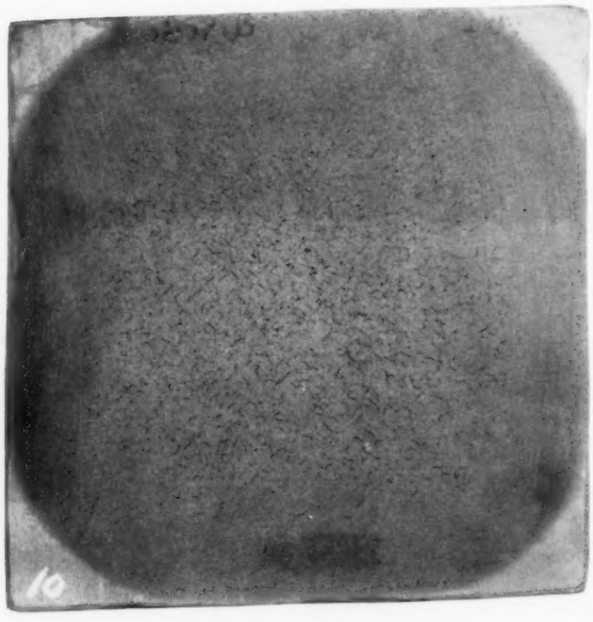
In an effort to find a quicker method of cooling which would also give positive prevention of flaking in large hot worked sections, the writer ran a series of tests in the forge shop of the Canton plant of Republic Steel Corporation in 1938. The material selected for these tests was type SAE 52100 steel of the following analysis: 1.07 per cent carbon, .36 per cent manganese, .015 per cent phosphorus, .017 per cent sulphur, .28 per cent silicon, and 1.46 per cent chromium. Two 25 in. x 25

TABLE II

Record of Tests to Establish Temperature of Flake Formation

Sample number	1–A	2–A	3–A	4–A	5–A	6–A
Initial temperature (end of forging), °F.	1500	1500	1500	1500	1500	1500
Air cooled to temperature of, °F.	900–1000	900–1000	900–1000	900–1000	900–1000	1350
Time of air cooling, hours	5	5	5	5	5	3
Quenched in	Salt	Salt	Salt	Salt	Water	....
Temperature of quenching bath, °F.	600	500	400	300	212	....
Time of soaking at quench temperature, hours	5	5	5	5	5	....
Reheated to temperature of, °F.	1500	1500	1500	1500	1500	....
Time of reheating, hours	3	3	3	3	3	....
Soaked at temperature of, °F.	1500	1500	1500	1500	1500	1350
Time of soaking, hours	4	4	4	4	4	6
Furnace cooled to temperature of, °F.	Room	Room	Room	Room	Room	Room
Time of furnace cooling, hours	28	28	28	28	28	25
Total time of cycle, hours	45	45	45	45	45	34
Brinell hardness	197	197	197	197	197	302
Flake condition	No flakes	No flakes	No flakes	Flaked badly	Flaked very badly	Flaked very badly





Figures 1, 2 and 3 — Test pieces from samples 2, 4 and 10 in Table I, showing no flaking in sample 4 processed according to the recrystallization cycle.

in. ingots from the same heat were heated to 2050 F in a 7 ft. x 11 ft. forging furnace fired with natural gas, and were forged with one heating down to test pieces 9⅞ in. x 9⅞ in. x 18 in. on a 1000 ton press. Forging was completed at approximately 1500 F. Each of the twelve test pieces was then cooled following a different cycle, details of which are set forth in Table I.

The results of these tests indicate positively that air cooling of the entire section to below the lower critical (Ar-1), followed by reheating and soaking above the upper critical (Ac-3) may be followed by cooling at any rate to obtain the desired hardness without resulting in a flake condition. Every test piece used in this experiment showed flaking except those which were brought down out of solution and then raised through the upper critical. None which was so treated showed flakes. Thus it seems safe to say that recrystallization before the piece cools to a flaking temperature will positively prevent flaking. Figures 1, 2 and 3 show the results from samples No. 2, 4 and 10.

TEMPERATURE OF FLAKE FORMATION

To determine the approximate temperature at which flakes occur, an additional run was made on a series of test pieces of type SAE 52100 steel, of the following analysis: 1.02 per cent carbon, .37 per cent manganese, .018 per cent phosphorus, .020 per cent sulphur, .28 per cent silicon and 1.45 per cent chromium. One 20 in. round ingot was heated and forged to 10 in. x 10 in. x 18 in. test pieces. Again, forging was completed at about 1500 F, and the pieces were cooled according to the cycles set forth in Table II.

The results of this series of tests show no flaking until the piece is allowed to drop below 400 F before reheating to above the upper critical. Cooling to 400 F showed no flakes, while the piece cooled to 300 F flaked badly. Hence, the formation of flakes occurs somewhere between 300 F and 400 F. This is contrary to the belief of many individuals, who feel that flakes must form at higher temperatures. We do not wish to argue the point — we simply submit the evidence.

Figures 4 and 5 show the results of samples No. 2A and 4A.

Based on these tests, the following procedure was set up for flake prevention in the forge shop:

TABLE III

Some Production Cycles in Present Use

Type	Air cool to, °F	Charge in furnace and hold		Raise temperature to, °F	Hold for, hr	Furnace cool to, °F, and pull
		At, °F	For, hr			
NE–9450	1000–1100	1000–1100	12–16	.....	....	800
NE–8949	1000–1100	1000–1100	12–16	.....	....	800
52100 + Mo	1100	1200	16	.....	....	....
High C–Mo	1000–1100	1200–1250	16	.....	....	....
4140	1100–1200	1100–1200	12	.....	....	900
4340	600–700	600–700	7	1250–1350	9–12	1200
NE–8744	1000–1100	1000–1100	12–16	.....	....	900
2340	800–900	800–900	6	1400	12	1000
3310	800–900	800–900	7	1300–1350	9	1200
Cr–Ni–Mo	600–700	600–700	7	1250–1350	9–12	1200
3312	600–700	600–700	7	1250–1350	9–12	1200

Air cooling to 1000 F.

Soaking out at 1000 F for 4 hours.

Reheating to 1500 F in 5 to 6 hours.

Soaking at 1500 F for 5 hours.

Cooling in air or furnace, according to hardness desired.

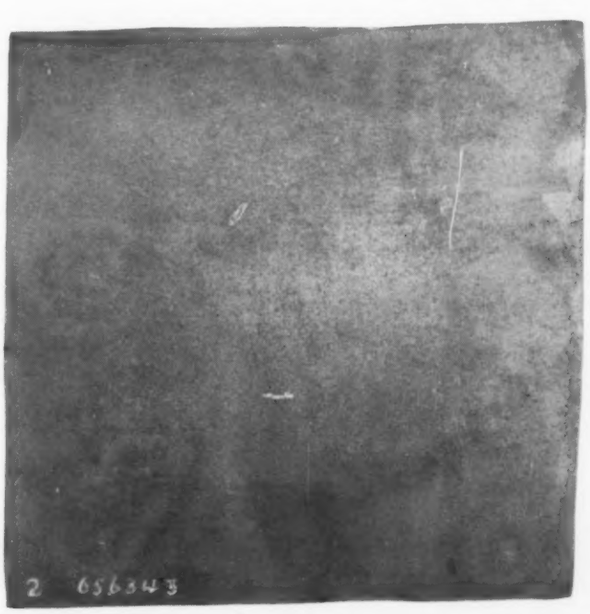
This cycle requires about 35 hours total time with 15 hours use of the furnace, plus whatever time may be added by slow cooling for hardness. The time for soaking and heating is for pieces approximately 10 in. x 10 in. in forge furnaces. The cycle is shown graphically in Figure 6, which also shows the cycle in previous use, wherein the steel was soaked out at 1500 F for 5 hours, then furnace cooled to about 100 F. This practice required use of the furnace during the entire cycle of 100-105 hours, and more important, did not positively prevent flakes.

Thus, positive prevention of flakes was secured in 40 per cent of the process time and with 15-30 per cent of the furnace time, a great help in the forge shop processing. Use of the new cycle was gradually extended to other types of steel in which flaking was prevalent, with equal success.

APPLICATION OF CYCLES TO MILL PRODUCTION

The application of cooling cycles of the foregoing type to mill production schedules presented problems

Figures 4 and 5 — Test pieces from samples 2-A and 4-A in Table II. Sample 2-A was cooled to 500 F before reheating, while 4-A was cooled to 300 F.



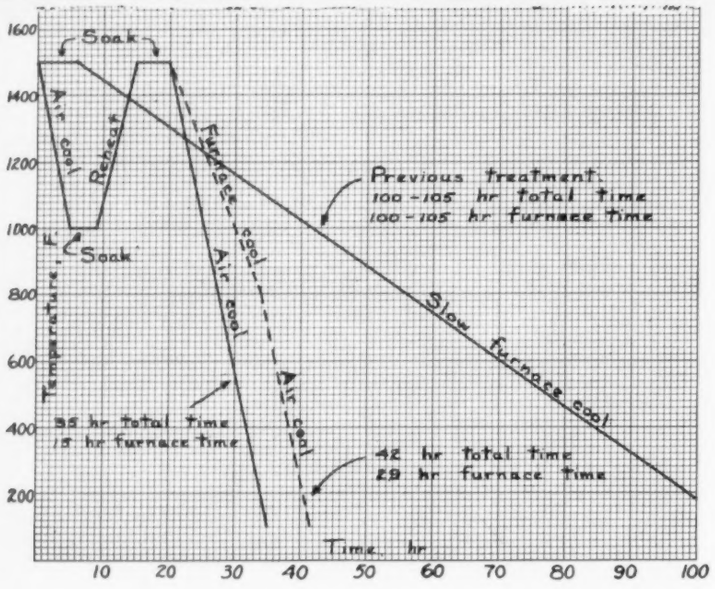


Figure 6 — Chart showing recommended cooling cycle for flake prevention compared with the slow cooling cycle previously used.

more complicated than those encountered in the forge shop, requiring the installation of heat treating furnaces in the bloom storage buildings. Through the efforts of the operating and metallurgical departments, gas-fired furnaces, of car or ball type, were installed, and products with flaking tendencies are given a precautionary treatment.

Since the furnaces have been installed, the metallurgical department has been conducting test work with a view to simplifying or shortening the cooling cycle. Much of this work has been directed toward reducing the first temperature drop, charging the steel into the furnace hotter, and reducing or eliminating subsequent raising of temperature, but at the expense of increased soaking time. In the light of this recent work, production cycles have been set up, some of which vary from the original plan of cooling below the lower critical and reheating to above the upper critical. One reason for this is that it seems that the desired final hardness (where lower hardness is desired) is attained with shorter cooling time when the steel is held for a longer period just below the upper critical (Ac-3) than when the complete recrystallization cycle is carried out.

Thus we find that on small billets of a steel which is not particularly prone to flaking, a straight soak and slow cooling may accomplish the purpose, but larger blooms and critical types of steels apparently require the "up-and-down" cycle for positive results. However, in some cases, it has not been found necessary to go completely up through the critical.

Table III shows some of the cycles now in use on production from blooming or billet mills. As is apparent, temperatures are varied for the different types of steel. The times of soaking naturally will vary with different types of furnace equipment and with different sizes of stock. Production cycles of 35-55 hours are obtained with these schedules.

In setting forth the foregoing data, the writer is not attempting to explain the cause of flake formation, nor to explain the reasons why the recrystallization cycle positively prevents them. It is enough to say that flaking has been prevented through processing as set forth. Through the courtesy of Republic Steel Corporation, the information is offered as a contribution to the general pool of "know-how" for whatever value it might have in the war effort.

DISCUSSION

PRESENTED BY

C. M. LICHY, Assistant Metallurgist, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

H. M. SMITH, Metallurgist, Crucible Steel Company of America, Midland, Pennsylvania.

O. A. BAMBERGER, Mechanical Superintendent, Republic Steel Corporation, Massillon, Ohio.

W. I. McINERNEY, Superintendent Heat Treating, Crucible Steel Company, Midland, Pennsylvania.

NICK CARTER, Metallurgist, Crucible Steel Company of America, Midland, Pennsylvania.

R. SERGESON, Chief Metallurgist, Crucible Steel Company of America, Pittsburgh, Pennsylvania.

C. P. HAMMOND, Superintendent Rolling Mills and Billet Department, Atlas Steels Limited, Welland, Canada.

C. M. LICHY: Due to the fact that we manufacture only steels of low alloy content, which are not particularly prone to "flaking", we at Jones and Laughlin Steel Corporation have encountered little difficulty with "flakes". Nevertheless, we have established a definite procedure for the handling of all grades that we suspect may be susceptible to this condition. This includes all grades .45 carbon and over with manganese above 1.50 and those grades containing various amounts of molybdenum. The blooms or slabs from these grades are taken off the blooming mill hot beds at temperatures in excess of 1500 F, and are placed in special insulated gondola railroad cars with insulated covers. The blooms or slabs are allowed to cool to 400 F before removing, a cycle requiring from 60 to 72 hours. Further, the hot rolled products from these slabs or blooms are placed into furnaces or slow cooling pits at temperatures above their Ac_3 critical point as predetermined by a dilatometer test.

Of particular interest at this time may be an experiment recently conducted by our Aliquippa metallurgical department with a manganese-molybdenum grade of steel. The top bloom from a special ingot revealed shatter cracks or "flakes" after etching as illustrated in the accompanying photograph. The large crack in the center does not have the characteristic appearance of flakes although the cause in this case is probably the

same. This bloom was not slowly cooled, as is the case with blooms of this grade.

A metallographic examination suggested that the cause of flaking in this instance was probably due to a non-uniform composition and heavy concentration of non-metallic inclusions.

Photomicrograph No. 1 shows an accumulation of non-metallic deoxidation products occurring at one of the cracks. Most of these may be identified as aluminum compounds while the lighter inclusions may be either titanium or zirconium compounds.

It will be observed in photomicrograph No. 2 that the structure above the crack is partly martinsitic (or "pseudo-martinsitic") while the area below is normal for the grade as rolled. These streaks of hardened material appear at lower magnifications as narrow bands much too small to be seen on a macro etch test. Since these bands were observed throughout the specimens, self-hardening of particular regions, as a result of segregation of such elements as manganese and molybdenum which confer air hardening characteristics is the only apparent explanation.

From the examination of this sample it was concluded that thermal stresses resulting from rapid cooling of the harder areas mentioned resulted in a microscopic quench crack which was further aggravated by the presence of large clusters of non-metallic inclusions. The etching probably intensified this cracking as shown on the macrograph.

This would illustrate that while we handle grades that are susceptible we have encountered little difficulty because of our procedure setup for the complete processing of these steels.

HUGH SMITH: Have you found that, if you eliminate flaking in the primary cooling, the secondary cooling is not important ?

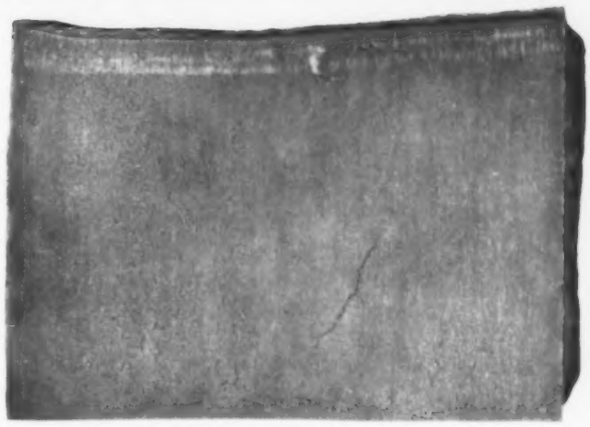
O. A. BAMBERGER: No, we haven't. If you don't get the size down small, it will come right back in.

HUGH SMITH: What is the critical size ?

O. A. BAMBERGER: It depends a whole lot on the type of steel.

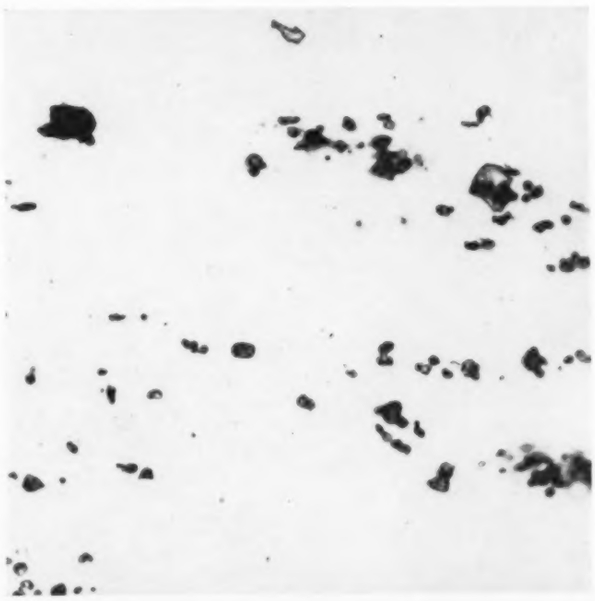
HUGH SMITH: What grade gives you more trouble with flakes than any other ?

O. A. BAMBERGER: We get flakes in practically

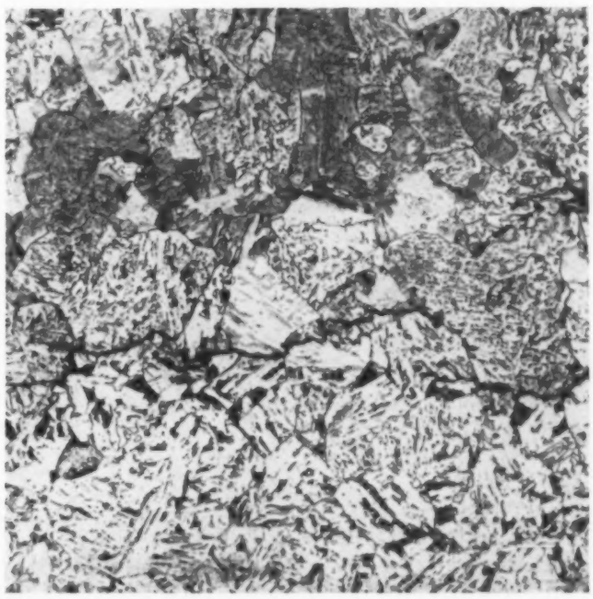


Typical shatter cracks on etched bloom. Top portion has been cut away for longitudinal etch and microscopic examination.

Photomicrograph No. 1 (500 x unetched) shows typical field of inclusions at one of the cracks. These are deoxidation products. Aluminum compounds with some titanium or zirconium compounds (lighter color).



Photomicrograph No. 2 (500 x etched 5 per cent Nital) shows microscopic crack at junction of normal structure and a harder streak (top) caused by local concentration of elements causing self hardening. This crack is over 2 in. from the bloom surface.



all the alloy types. SAE 52, 100, 4340 and 4360 are all bad.

HUGH SMITH: What is the largest size in which you don't have to worry about flake ?

O. A. BAMBERGER: I would say, for 4350, down below an inch and a half.

HUGH SMITH: Do you find any variation in your soaking time, with the cycle that you presented, according to the section of the bloom ?

O. A. BAMBERGER: Yes. The larger the bloom, the more we have to soak them. We always determine the amount of soaking time by the size of the bloom that we get, figuring about an hour to the inch.

We have run this cycle in our forging department around 1200 ton a month, and we haven't had any flaking in five years. We use the cycle all the time. I don't think they make anything under around eight inches in diameter.

HUGH SMITH: Say you are running a 12 x 12 bloom and going to cool it according to that cycle, and then roll it again into an eight-inch round.

O. A. BAMBERGER: We slow-cool it twice.

HUGH SMITH: How would you cool it the second time ?

O. A. BAMBERGER: Down in our bar mills we use cooling pits.

HUGH SMITH: A long, slow cooling ?

O. A. BAMBERGER: Yes, but I don't think that is necessary. We do that because of the equipment we have there. In my opinion they should be cooled the same in both cases. Unfortunately we do not have cooling furnaces at our mills, so, we use cooling pits with the long cycle.

W. I. MCINERNEY: What was the highest Brinell in your steel free of any flake ?

O. A. BAMBERGER: A Brinell of 269 is the highest here that is not flaked, but we have had 400 Brinell or higher.

W. I. MCINERNEY: Would you consider that steel in precarious condition, if it were reheated for forging ? There must be some strain or dangerous condition of that high Brinell.

O. A. BAMBERGER: I wouldn't throw it in the highest temperature furnace.

W. I. MCINERNEY: It would be in dangerous condition compared with 187 Brinell.

NICK CARTER: If you take a 4 x 4 steel that is flaking and roll it down, will it take the flakes out ?

ROBERT SERGESON: If you rolled it down to a relatively small size, it would. Did you quench and fracture some of those etch tests which apparently did not show flakes ?

O. A. BAMBERGER: No, we didn't, but it was done later on chrome nickel molybdenum.

ROBERT SERGESON: I might mention that we have investigated many of our acid open hearth steels. Some etched discs from these apparently were not flaked; however, after quenching them to full hardness and fracturing them, some few flakes appeared.

O. A. BAMBERGER: We didn't do that on this test, but we tried it later on chrome-nickel-moly, one and a half nickel, and didn't find anything. Of course, we just broke them in half and cut out an etch.

C. P. HAMMOND: In your investigation you have bloomed, for instance, billets to eight inches square, you treat it as such to take out the flakes and you have no flakes, and then heat it and re-work it again, would you follow the same procedure again ?

O. A. BAMBERGER: The same thing, yes.

C. P. HAMMOND: In other words, you produce more flakes ?

O. A. BAMBERGER: You would if you worked them again. If you get them up to high temperature and work them again, you handle them the same in the second working as you do on the first.

HUGH SMITH: How much reduction in rolling is necessary to close up flakes ?

ROBERT SERGESON: It depends on the grade of steel. Generally, flaked billets rolled to three inch round or under, do not show flakes.

MEMBER: What size billet ?

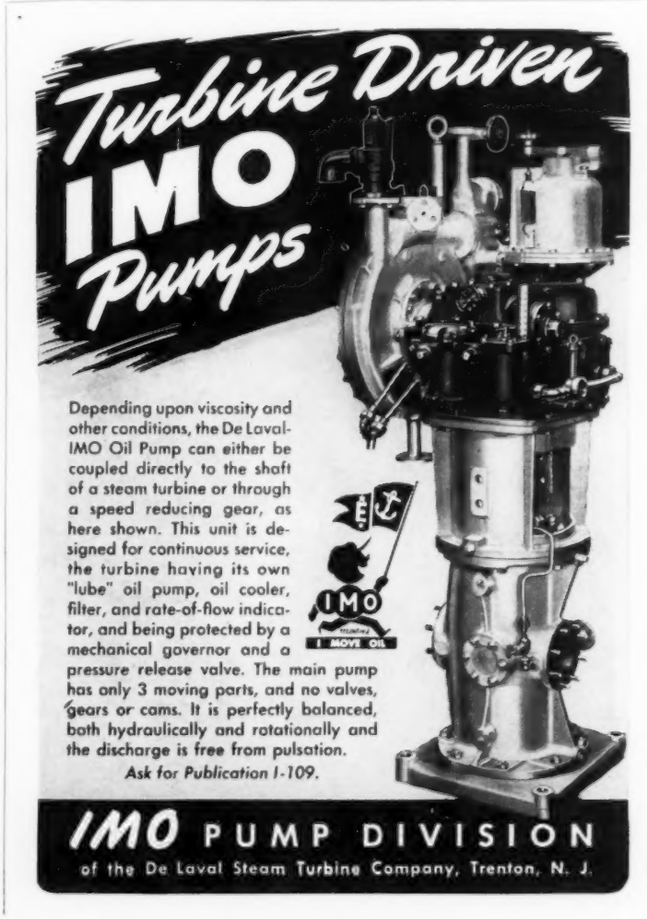
ROBERT SERGESON: Again it depends upon grade of steel and finished size. I do not believe a general statement can be made.

HUGH SMITH: About how many furnaces are required for 100 tons of product rolled off the blooming mill ?

O. A. BAMBERGER: We get 100 tons in two of our furnaces.

HUGH SMITH: Do you find any difference between electric and open hearth steels ?

O. A. BAMBERGER: No, we find they all flake if you do not cool them properly.


Turbine Driven
IMO
Pumps
Depending upon viscosity and other conditions, the De Laval-IMO Oil Pump can either be coupled directly to the shaft of a steam turbine or through a speed reducing gear, as here shown. This unit is designed for continuous service, the turbine having its own "lube" oil pump, oil cooler, filter, and rate-of-flow indicator, and being protected by a mechanical governor and a pressure release valve. The main pump has only 3 moving parts, and no valves, gears or cams. It is perfectly balanced, both hydraulically and rotationally and the discharge is free from pulsation.
Ask for Publication I-109.
IMO
I MOVE OIL
IMO PUMP DIVISION
of the De Laval Steam Turbine Company, Trenton, N. J.

A. I. S. E. *Standard Designs* FOR *Crane Track Wheels*

. . . . continuing the activities which resulted in standard specifications for electric overhead mill type cranes, the A. I. S. E. Crane Committee has developed standards for crane track wheels . . . .

▲ IN a letter dated August 25, 1942, C. T. Ripley, chief engineer, Technical Board of the Wrought Steel Wheel Industry, suggested that the Association of Iron & Steel Engineers cooperate with the manufacturers in the standardization of crane track wheels. This board had completed similar standards for railroad and street car wheels and were desirous to extend the work to the double flanged wheels used on mill type cranes.

This letter was referred to the Board of Directors of the Association who granted approval of this work at their September 23, 1942 meeting. F. D. Egan, general chairman of the A.I.S.E. Standardization Committee, then appointed a sub-committee of the crane committee to develop such standards.

This group was later expanded to include representatives of the Technical Board of the Wrought Steel Wheel Industry and of the crane manufacturers, and the following participated in the work:

F. W. Cramer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.—Chairman.

E. L. Anderson, Bethlehem Steel Company, Johnstown, Pa.

H. W. Ball, Morgan Engineering Company, Alliance, Ohio.

W. L. Poto, Alliance Machine Company, Alliance, Ohio.

H. J. Walters, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

J. T. Bradford, Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

S. R. Cox, Morgan Engineering Company, Pittsburgh, Pa.

D. W. O'Leary, Bethlehem Steel Company, Johnstown, Pa.

N. Poehner, Bethlehem Steel Company, Johnstown, Pa.

W. H. Mursch, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.

R. W. Steigerwalt, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa., (representing the Wrought Steel Wheel Committee).

The preliminary work of the committee was the examination of hundreds of crane wheel orders placed during the last two years with two of the major manufacturers and a tabulation by each of possible standard sizes and dimensions. These were referred to a few of the major manufacturers and users for comments, and later a compilation of all data was presented to the sub-committee which prepared the proposed standards.

BASIS OF STANDARDS

A. It is the opinion of the committee that three classes of wheels are needed:
   1. Standard wheels which will be applied to all new installations.
   2. Standard wheels, which will be in addition to above, that are required for replacements on existing cranes.
   3. Unusual wheels which are required on existing equipment which will not be finished by the wheel manufacturer, but may be obtained as a rough blank. The user will be expected to make changes where possible to use standard wheels rather than order these special blanks, which during the emergency will be difficult to obtain.

The committee feels that the standard wheels should cover roughly 90 per cent of the requirements.

B. These standard wheels apply to heavy duty mill type cranes, ore bridges, charging machines, etc., in line with the A.I.S.E. Specifications for Electric Overhead Traveling Cranes for Steel Mill Service (Iron and Steel Engineer, August, 1942. A.I.S.E. Yearbook, 1942, p. 407).

C. The wheel manufacturers suggested that keys be eliminated from all wheels and that press fits following the railroad specifications be used. At present no keys are used on wheels or gears on diesel drives, modern trolley cars, or other railroad

equipment. Shrink fits may destroy the heat treatment on the wheels and cause unbalanced stresses. The committee considered this suggestion and recommends this process be tried out, but in the standards the hub diameters are heavy enough to allow for full size keys.

D. Two types of tread are required—
   1. Straight tread as shown on the sketch.
   2. Tapered tread as shown on the sketch.

E. Two widths of tread are required for many of the sizes in both the straight and tapered design.
   1. One for rails up to the 131 pound section.
   2. One for the heavy rails of 171 or 175 pounds.

F. Tread diameters—
   For straight tread wheels — 12 in., 15 in., 18 in., 21 in., 24 in., 27 in., 30 in. and 36 in.
   For tapered tread wheels — 24 in., 27 in., 30 in. and 36 in.

G. A tabulation of other required wheels with different hub diameters and lengths than the standards has also been compiled as "X" wheels.
   The finished tabulation contains a standard nomenclature for each wheel which will be used on all future wheel orders.

After the above basic principles were decided the tabulations and suggestions submitted by the various members were considered and the tabulations (Tables I, II, III and IV) resulted.

Tables I and II are to be used for application to new and existing equipment, Tables III and IV for maintenance of existing equipment only.

CONTOURS

Two contours are shown, one for wheels with straight tread, another for wheels with tapered tread. The radius at the throat of the flanges is shown as $\frac{3}{8}$ in. This is slightly larger than the radius on the corner of the rails. The slope of the flange is shown as 10 degrees and uniform height and thickness of flanges has been adopted. The contour for tapered tread was designed with a taper of 1 in. in 16 in., in accordance with paragraph 28-c of the Standard Crane Specifications. The diameter of the wheel is measured at the center line of the tread.

Tread widths are specified in accordance with the rail sections and loadings recommended in the Standard Crane Specifications.

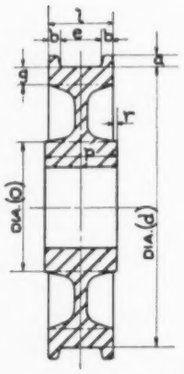
The wheels have a classification number which should be of exceptional value in specifying the type of wheel wanted. An example of this is Table I, wheel CRS-24-A. The letters CR indicate crane service, S straight tread, 24 the diameter of the wheel and A the type of wheel of this diameter, as this table shows four designs of wheels. Table II has a similar wheel, CRT, the T standing for tapered tread. Tables III and IV show an X after the design letter, the X indicating that the wheels are for use under existing equipment only, and are not to be used for design of new equipment.

SPECIFICATIONS

Wheels are specified either in the rough, untreated with allowance for finishing, or furnished with contour finished. When finished contour is specified the wheels are, as a rule, heat treated, although untreated wheels may also be furnished to contour.

MOUNTING PRACTICE

It is recommended by the manufacturers that wheels should be mounted on the axles with a press fit. It is



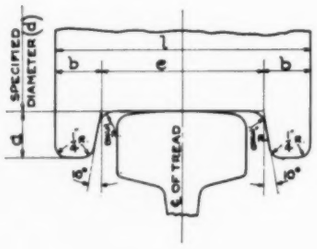
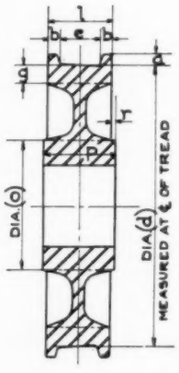


TABLE I
STRAIGHT TREAD WHEELS
FOR USE WITH NEW OR EXISTING EQUIPMENT

WHEEL CLASS	CRS 12A	CRS 15A	CRS 15B	CRS 18A	CRS 21A	CRS 24A	CRS 24B	CRS 24C	CRS 24D	CRS 27A	CRS 27B	CRS 27C	CRS 30A	CRS 30B	CRS 30C	CRS 36A
a	3/4"	3/4"	3/4"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"
b	13/16"	13/16"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"
d	12"	15"	15"	18"	21"	24"	24"	24"	24"	27"	27"	27"	30"	30"	30"	36"
e	2 7/8"	2 7/8"	3 1/8"	3 1/8"	3 1/8"	3 1/8"	3 1/2"	4 3/4"	4 3/4"	3 1/2"	4 3/4"	4 3/4"	3 1/2"	4 3/4"	4 3/4"	4 3/4"
g	5/8"	1"	1"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2"	2"	2"	2"	2"	2"	2"	2"	3"
l	4 1/2"	4 1/2"	5 1/8"	5 1/8"	5 1/8"	5 1/8"	5 1/2"	6 3/4"	6 3/4"	5 1/2"	6 3/4"	6 3/4"	5 1/2"	6 3/4"	6 3/4"	6 3/4"
o	5 3/4"	7 1/2"	7 1/2"	7 1/2"	10"	8"	11"	11"	12 1/2"	11"	11"	14"	12"	12"	15"	15"
p	5"	5 1/2"	5 1/2"	6"	5 3/4"	6"	6"	7 1/2"	7 1/2"	6 1/2"	7 1/2"	7 1/2"	7"	7 1/2"	7 1/2"	7 1/2"
r	1/4"	1/2"	3/8"	7/16"	5/16"	7/16"	1/4"	3/8"	3/8"	1/2"	3/8"	3/8"	3/4"	3/8"	3/8"	3/8"



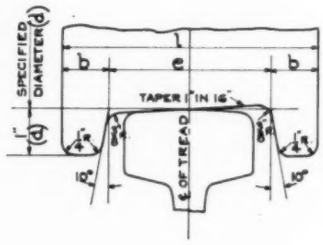


TABLE II
TAPERED TREAD WHEELS
FOR USE WITH NEW OR EXISTING EQUIPMENT

WHEEL CLASS	CRT 24A	CRT 24B	CRT 24C	CRT 24D	CRT 24E	CRT 27A	CRT 27B	CRT 27C	CRT 30A	CRT 30B	CRT 30C	CRT 36A
a	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"
b	7/8"	7/8"	7/8"	7/8"	7/8"	7/8"	7/8"	7/8"	7/8"	7/8"	7/8"	1"
d	24"	24"	24"	24"	24"	27"	27"	27"	30"	30"	30"	36"
e	4"	4"	4 1/2"	5 1/2"	5 1/2"	4 1/2"	5 1/2"	5 1/2"	4 1/2"	5 1/2"	5 1/2"	5 1/2"
g	1 1/2"	1 1/2"	1 1/2"	2"	2"	2"	2"	2"	2"	2"	2"	3"
l	5 3/4"	5 3/4"	6 1/4"	7 1/4"	7 1/4"	6 1/4"	7 1/4"	7 1/4"	6 1/4"	7 1/4"	7 1/4"	7 1/2"
o	9"	11"	11"	11"	12 1/2"	11"	11"	14"	12"	12"	15"	15"
p	6"	6"	6 3/4"	7 1/2"	7 1/2"	6 3/4"	7 1/2"	7 1/2"	6 3/4"	7 1/2"	7 1/2"	7 3/4"
r	1/8"	1/8"	1/4"	1/8"	1/8"	1/4"	1/8"	1/8"	1/4"	1/8"	1/8"	1/8"

not felt necessary to use keys. However, the wheels are designed so that there will be sufficient hub wall thickness for the use of keys when used with shafts according to present crane design.

The Association of American Railroads, Mechanical Division, Wheel and Axle Manual, gives very valuable information in regard to the preparation of the wheels and axles for mounting. This manual describes the different types of machine tools, including mounting press and recommended practices used in mounting wheels. The types of tools to be used in machining both wheels and axles, type of lubricant to be used, and other information which will be very helpful in the maintenance of mill cranes and other mill equipment are covered in this manual.

The manual gives the recommended practice for pressing wheels on shafts without the use of keys. A shrink fit is not satisfactory or considered safe for heat treated crane wheels unless the fit is made by immersing the wheel in some medium at a temperature not exceeding 300 F.

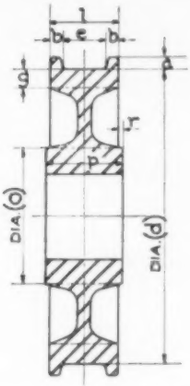
It is usual practice in mounting wheels to allow a difference of .001 in. in bore for each inch specified. In other words, if a 6 in. finish bore is used the finish bore of the wheel should be .006 in. less than the diameter of the axle. It is recommended that the wheels be fitted to the axle, that is, the axle or shaft be finish machined and the dimension obtained with micrometers; the wheel then to be finish bored to fit the shaft using the proper allowance for fitting. It is very important that the proper lubricant be used, and the recommended practice is to use the following mixture: 12 lb of white lead to one gallon of boiled linseed oil. The white lead and oil should be thoroughly mixed and only a sufficient amount made for a few days operation. The oil dries very quickly, and the mixture is spoiled if held too long. It is important to stir the mixture before each application and very important to see that no dirt or grit comes in contact with the brush or container of the mixture.

METHOD OF ORDERING WHEELS

Wheels should be ordered to the wheel classification shown in the tables, stating the rough bore desired. The rough bore should be ¼ in. less than the desired finish bore. The order should state whether the wheels are to be untreated in the rough, untreated with finished contour, heat treated in the rough, or heat treated with finished contour. It is the usual practice in furnishing wheels with finished contour to work to a diameter of plus or minus one tape size. A tape size is equal to ⅛ in. in circumference.

These proposed standards have been accepted by the Wrought Steel Wheel Industry and will appear in future editions of their catalogues. They are available at the present time. It is the opinion of the committee that the use of these standard wheels will enable manufacturers to carry stocks of the popular sizes and greatly expedite deliveries.

These standard wheels will be included in the next revision of the Standard Crane Specifications.



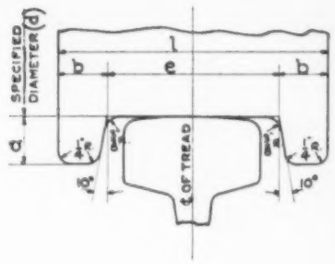
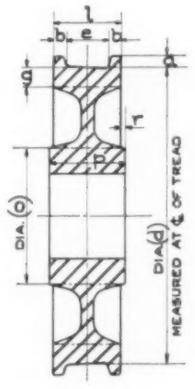


TABLE III
STRAIGHT TREAD WHEELS
FOR USE WITH EXISTING EQUIPMENT ONLY

WHEEL CLASS	CRS 12AX	CRS 12BX	CRS 18AX	CRS 20AX
a	4¾"	4¾"	1"	1"
b	6⅛"	6⅛"	1"	1"
d	12"	12"	18"	20"
e	2⅜"	2⅞"	4¾"	3⅛"
g	⅝"	⅝"	1½"	1½"
l	4"	4½"	6¾"	5⅛"
o	5¾"	6½"	9"	7½"
p	5"	6"	6¾"	5⅞"
r	½"	¾"	0"	⅜"



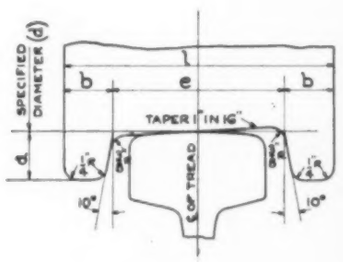


TABLE IV
TAPERED TREAD WHEELS
FOR USE WITH EXISTING EQUIPMENT ONLY

WHEEL CLASS	CRT 18AX	CRT 18BX	CRT 20AX	CRT 21AX	CRT 27AX	CRT 30AX
a	1"	1"	1"	1"	1"	1"
b	⅞"	⅞"	⅞"	⅞"	1"	1"
d	18"	18"	20"	21"	27"	30"
e	4¾"	5½"	4"	4"	6"	6"
g	1½"	1½"	1½"	1½"	2"	2"
l	6½"	7¼"	5¾"	5¾"	8"	8"
o	11"	11"	7½"	10"	13½"	13½"
p	6½"	8"	6"	6"	7"	7"
r	0"	⅜"	⅛"	⅛"	-½"	-½"

Continuous Production Line for Tubular Railway Axles

. . . . greater strength with 25-42 per cent less weight is the performance of tubular axles made by the process used in this initial straight-line production unit . . . .

▲ THE idea of producing tubular railway axles is not new and has been subject to experiment since the early days of railroad operation, but a new process, just put into operation by the Pittsburgh Steel Company at their Allenport, Pennsylvania plant, represents the first production unit for this type of axle, which has demonstrated definite advantages over the types of solid steel axles now in general railroad use. The process and tests were completed three years ago, but the difficulties of securing equipment and building a suitable plant for launching a new product under war conditions delayed completion of the plant.

The raw material for the axle consists of seamless tubing of SAE-1040 stock, formed at the adjoining Pilger mill of the Pittsburgh Steel Company. The Pilger process is a unique method of producing seamless tubing. After cylindrical billets are pierced, the rolling process differs fundamentally from the usual method of completing the tubes. The rolls used to form the tubing are elliptical and they rotate in a direction opposite to the feed of the steel which is pressed against the rolls by a ram. The steel is fed forward by the ram when the pass between the rolls is wide. As the pass narrows, the rolls produce an effect similar to the blows of a forging hammer. The inside diameter of the tubes is maintained by the use of a mandrel. The resulting product has the superior qualities which naturally result from a forging operation in comparison to a rolling operation.

After being cut to suitable sizes, the tubes are taken to the axle plant and are passed through a continuous tube-end heating furnace, essentially a large gas-fired slot-type forge furnace, which heats one end of each tube. The heated ends then are upset in a tube upsetting press, and then shaped on a 3000 lb drop hammer to form the journals and wheel seats of the axle.

Following this operation, the tubes are returned to the heating furnace over a roller conveyor, and the opposite ends are heated, upset and forged in the same manner. In normal operation, each alternate tube is new material, while the adjacent pieces are going through the process for the second end.

The axles which have been finished at both ends then pass to a continuous hardening furnace fired with natural gas and automatically controlled at about 1500 F. After emerging from the furnace, axles are straightened and quenched in pairs. The combined straightening and quenching equipment is so designed that the ends of the axles are plugged, and quenching takes place only on the outside, while the axles are held against the revolving straightening rolls.

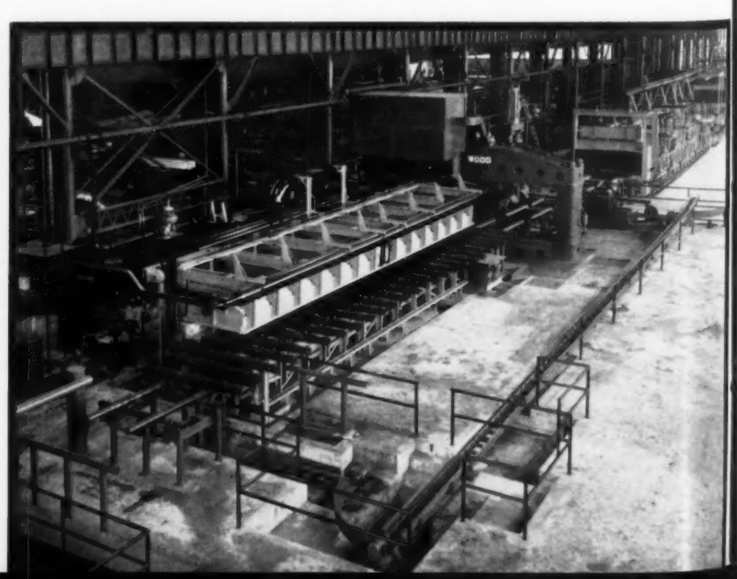
Following quenching, the axles are passed through a forced convection draw furnace operating at about 700 F, and then go through a cooling tank. In a final operation, the insides of each end are simultaneously machined to exact centers on a special machine and are ready for shipment.

The axles are designed to be machined to the same journal and wheel seat dimensions as the conventional type of solid axles. They are completely interchangeable with solid axles and can be machined on the usual types of lathes with the addition of suitable fittings for centering the tubular material.

Between the wheel seats the axles are straight and are left with the natural finish produced by the Pilger mill operation. The only difference in the outside dimensions is in the portion between the wheel seats, since the tubular axles do not have the fillet and the subsequent taper toward the center, which is typical of solid axles.

Substantial savings in weight result from the use of the new product as well as greater resistance to distor-

Figure 1 — Production line methods are used in the new tubular axle plant of the Pittsburgh Steel Company at Allenport, Pennsylvania. In the left foreground is the hydraulic accumulator which maintains oil pressure to operate the press and the hammer. At center is the tube end heating furnace followed by the upsetting press and the forging hammer. Heat treating is completed in the furnaces in the right background.



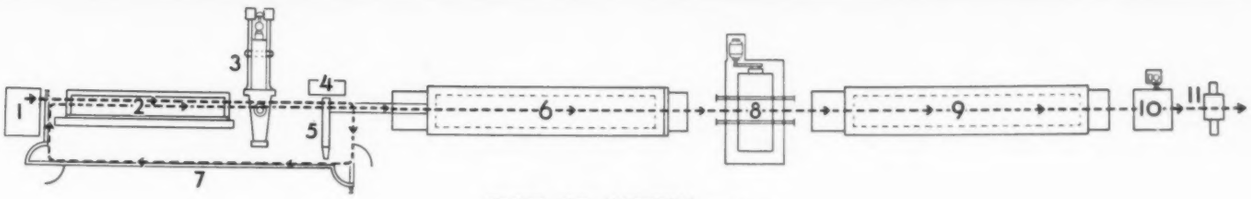


Figure 2 — Layout of straight-line tubular axle unit — 1. Elevator and loading table; 2. continuous tube end heating furnace; 3. 900/900 ton tube upsetting press; 4. 3000 pound drop hammer; 5. oscillator; 6. continuous hardening furnace; 7. conveyor to return tubes for processing opposite end; 8. quenching machine; 9. forced convection draw furnace; 10. cooling tank; 11. centering machine.

tion and greater fatigue resistance. The saving in weight per axle varies from 177 pounds on axles with 5 in. x 9 in. journals to 510 pounds on axles with 6½ in. x 12 in. journals. These savings in weight range from 25.1 per cent to 42.8 per cent.

Railroad operating officials report varying estimates of the cost of hauling one ton of dead weight per car per year on the basis of 10,000 miles of operations a year. These estimates range from $12 to $18 per ton per car per year. Assuming an average cost of $15 per ton per car per year for hauling dead weight, the annual savings would range from $7.53 to $15.30 per car.

The saving in unsprung weight also materially reduces rail hammer and may be expected to result in a substantial ultimate saving in maintenance of way expenses when a sufficient number of cars become equipped with tubular axles. More important than this, however, is the saving in maintenance cost to be secured through longer life of the tubular axles with far less frequent replacement.

Two types of tests were employed on the axles. The first part consisted of distortion or bending tests to determine stiffness under various loads. In these tests, collars were fitted on the wheel seats with the same tolerances with which wheel press fits are made. It was found that the deflection of tubular axles was less than that of solid axles under equivalent loads. In the solid axles, failure through permanent distortion began at 169,000 lb and continued as the loads were increased. Actual yield occurred at 225,000-226,000 lb.

For tubular axles, loads of 369,600 to 431,000 lb were required to set the structures permanently. This indicated 56 per cent greater strength for the tubular axles over the solid axles before plastic deformation developed.

Fatigue tests were conducted at the physical testing laboratory of the Timken Roller Bearing Company with the axles loaded on the basis of 19,000 lb stress at the wheel seats. The tubular axles withstood over 88,000,000 stress reversals which was equivalent to 155,000 miles on 36 in. wheels, without failure. Similar tests with solid axles at 19,000 lb stress resulted in failure at the wheel seats at 875,000 to 2,755,000 stress reversals.

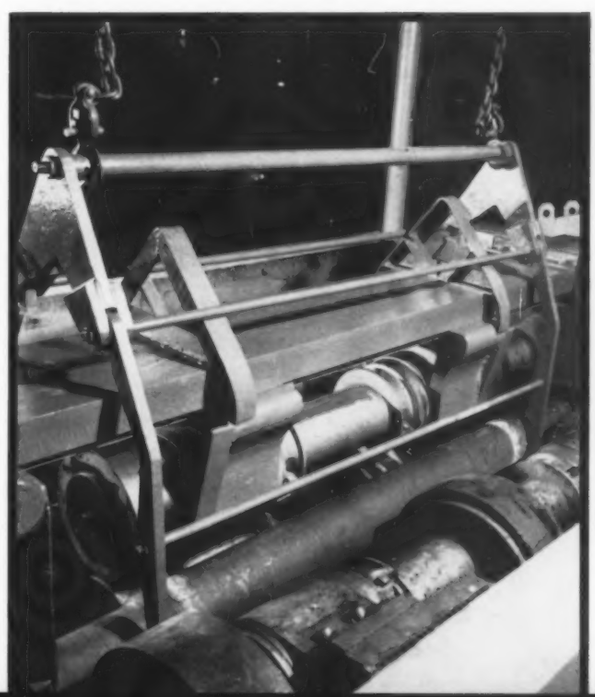
The greater physical strength of the tubular axles is attributed to several factors. First, the greater external diameter between the wheel seats provides greater strength than the solid axles. Second, the tubular material, as produced by the Pilger process, is a forged product with the usual physical benefits conferred by forging. Third, subsequent heat treating further improves the physical characteristics. The heat treatment also makes the tubular axles less subject to wear at the journals.

A further advantage has been found, according to studies made by plant engineers, in that tubular axles run cooler which should prove a factor in making them less susceptible to wear and to some types of hot boxes. Comprehensive data on this point cannot be secured until large numbers of the axles have been in service for some period of time.

In addition to laboratory tests, numerous axles produced on an experimental basis have been in actual service on railroads for several years. In one of these service tests, tubular axles and solid axles were placed on the same trucks of heavy dump cars used on the Monessen and Southwestern Railway. Considerably less wear was found on the tubular journals than on solid journals, especially endwise, after identical periods of service.

The plant is designed for an initial production of 250 axles per 8 hr turn with provision being made for subsequent expansion by the addition of more equipment. The process is protected by patents.

Figure 3 — Detailed view of straightening rolls at new tubular axle plant of the Pittsburgh Steel Company at Allenport, Pennsylvania. After straightening, water is raised to the level of the axles for quenching. The ends of the axles are automatically plugged to prevent water from entering the interior.



RECLAIMED *Sewage Water* FOR INDUSTRIAL *Uses*

. . . . as a means of improving water conditions at the Sparrows Point plant, Bethlehem Steel Company has installed a treatment plant for reclaiming sewage water from the city of Baltimore . . . .

by L. F. Coffin, SUPERINTENDENT
MECHANICAL DEPARTMENT
BETHLEHEM STEEL COMPANY
SPARROWS POINT, MARYEAND

▲ THE location of the Sparrows Point Plant on the Patapsco River near Baltimore makes available an unlimited supply of water for coke oven, blast furnace and open hearth cooling. Unfortunately this water is salt, having a chloride content of about approximately 4000 ppm, compared with an average of about 17,000 ppm for sea water along the eastern coast. The daily pumpage of salt water is about 170,000,000 gal. Up until December 1942, the only source of fresh water was artesian wells, 32 of which with capacities ranging from 200 to 900 gpm, were in continuous operation. This water was used for drinking, sanitary and boiler purposes, and for roll cooling in continuous hot and cold strip mills, pipe mills, rod mills and plate mills. Salt water is entirely unsuited for use in these mills due to its corrosive action on highly finished roll surfaces. It has of course been necessary to use recirculating and cooling systems on all fresh water applications on mills in order to conserve the supply of artesian well water, particularly with the increasing demands of an expanding plant and the steadily decreasing static head of the ground water.

The industrial area south, southeast and east of Baltimore has been dependent, in large measure, on artesian well supply. A line drawn roughly from southwest to northeast, from Washington to Wilmington and passing through the northern limits of Baltimore, follows an outcrop of granite which gradually slopes towards the southeast. At Sparrows Point, 13 miles southeast of the center of Baltimore, the depth of the granite below the ground level is about 650 ft. A large part of the industrial area is supplied from artesian wells drawing on various strata and lenses included above this granite. Study indicates that due to the rapid industrial expansion during the last four years, the withdrawal from the ground water in this basin has been 2½ times the probable amount of rain water seeping in to replenish it. As a result, the static head has been continuously dropping. The depression of the water table below ground level has been as follows:

Year	Depression, ft
1898	10 to 15
1903	24 to 29
1909	4 to 36
1913	8 to 45
1917	15 to 60
1930	50 to 97
1937	59 to 110
1938	Up to 102
1939	Up to 115
1940	75 to 153

Coincident with this has come an increasing deterioration in the quality of the water supply due to infiltration of salt water, as illustrated in Figures 1 and 2. Both of these conditions were rapidly becoming more serious and over two years ago steps were therefore taken to investigate other sources of fresh water supply for the increased needs of the steel plant.

Presented before A. I. S. E. Philadelphia District Section Meeting, March 6, 1943.

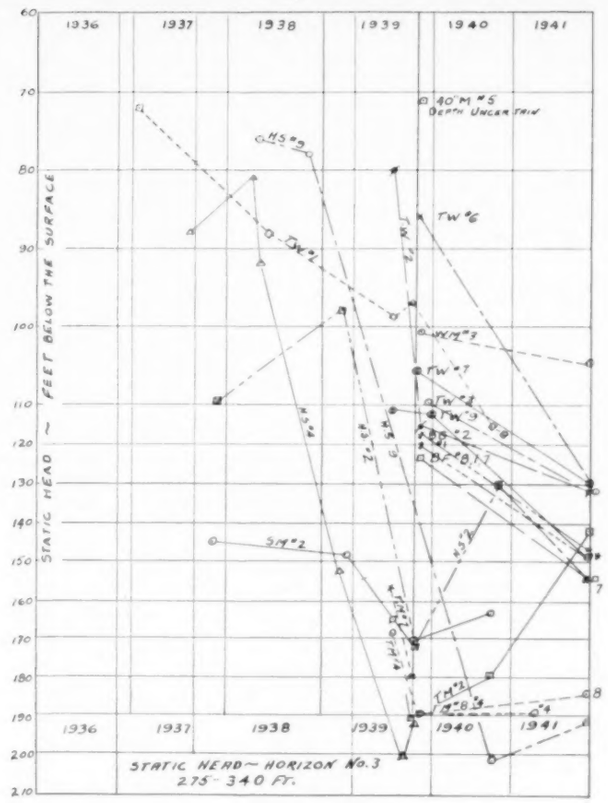


Figure 1 — Records over the past few years show a gradual drop in the ground water level.

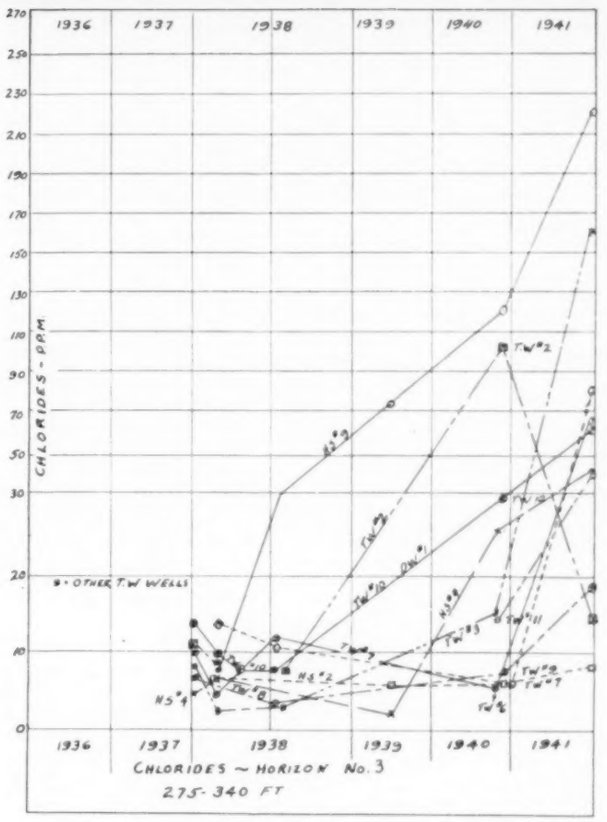
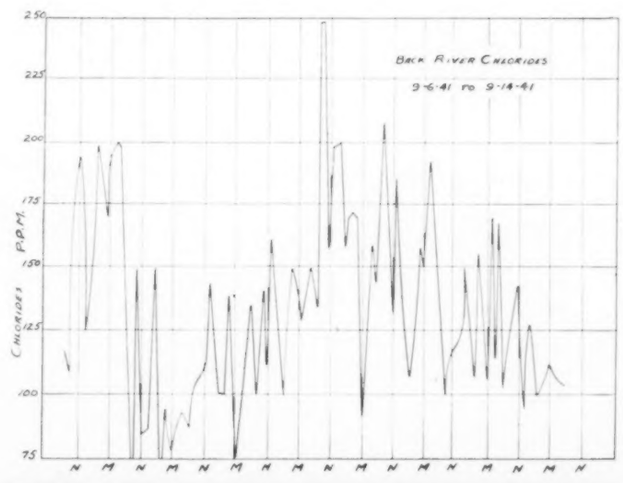


Figure 2 — The drop in water level was accompanied by a marked increase in chloride content.

Figure 3 — Chart showing wide fluctuation of chlorides in relatively short time.



It was very clear that there was no hope of receiving any substantial quantity of water from Baltimore City as evidenced by the fact that in January 1943 about 165,000,000 gal per day was used from their storage reservoirs whereas the safe yield of the drainage areas feeding these reservoirs is placed at only 148,000,000 gal per day. Other sources of supply were investigated, such as the Patapsco River, the Gunpowder River, Deer Creek, but none of these were found suitable for the company. Studies of additional sources of artesian well water farther away from Sparrows Point showed those to be unreliable as they are also fed from the same underground basin.

However, at the Baltimore City sewage disposal plant at Back River, 5½ miles distant from Sparrows Point, there was available a continuous flow of partly

Figure 4 — Settling basins at the Baltimore city sewage disposal plant.

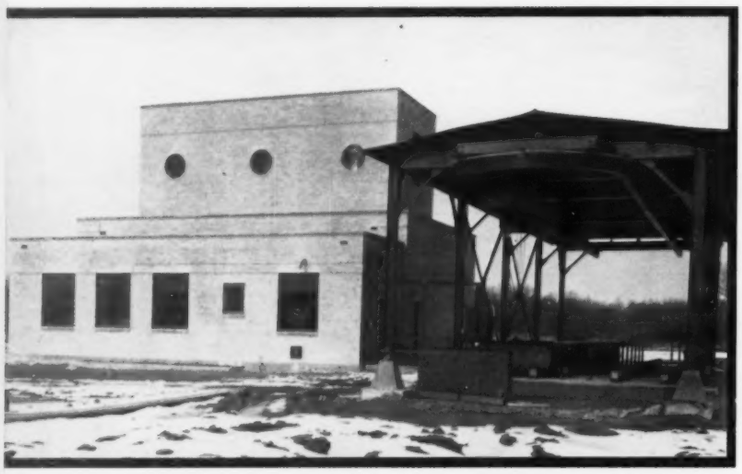


Figure 5 — View of treatment plant showing chlorine shed at right.

▲

Figure 6 — Sewage water treatment plant, showing flocculators.

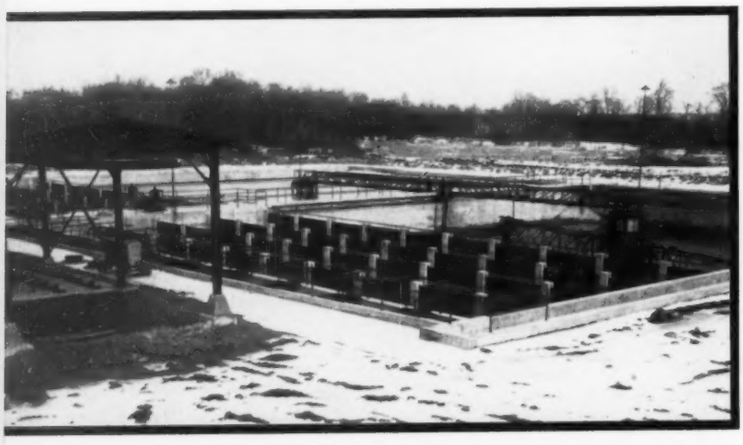


Figure 7 — Control room in treatment plant.

↓

treated city sewage, with a safe yield always in excess of 85,000,000 gal per day, apparently a permanent supply which was being wasted into Back River. Through the cooperation of the city sewage engineers, this supply was studied over a period of several months. One important consideration was the chloride content which was found to vary from 50 to as high as 600 ppm under certain conditions of river level and rain fall. Figure 3 shows the fluctuations in the chloride content. At the same time extensive tests were also run on the circulating system of some of the Sparrows Point finishing mills to determine the effect of variations in the chloride content on roll surfaces. Lead impressions were made to check this. It was concluded that a top limit of 175 ppm of chlorides would be acceptable, though a lower figure would be preferable, as the lower chlorides show less etching on the roll surfaces. Sources of contamination of the Baltimore city sewage system were studied for several months and were found to consist of industrial processes such as meat packing and pickling, soap manufacturing, salt pickling of hides, discharges from zeolite water softening plants, and of seepage from the river through leaks in the low parts of the sewage system. Many of these sources of contamination have been reduced or eliminated, so that the chloride content is now running consistently below the average at the start of the investigation. During January 1943, the average was 100 ppm.

Laboratory tests were also run on the better known commercial coagulants to determine the treatment needed to properly process the effluent. From 10,000,000 to 20,000,000 gal per day are discharged from an activated sludge plant, and this water was found to have a turbidity of from 5 to 12 ppm, requiring no processing except chlorination. For the effluent from the trickle filter plant, discharging a minimum of 65,000,000 gal per day, it was found that alum made a satisfactory coagulant.

In view of the war emergency and the contemplated expansions of the steel plant it was planned to provide for a possible ultimate take of approximately 50,000,000 gal per day. A contract was made with the city of Baltimore, rights of way were secured and engineering and construction proceeded. At Back River a treatment

Figure 8 — Dry alum feeders, used for proportioning coagulant to the water.

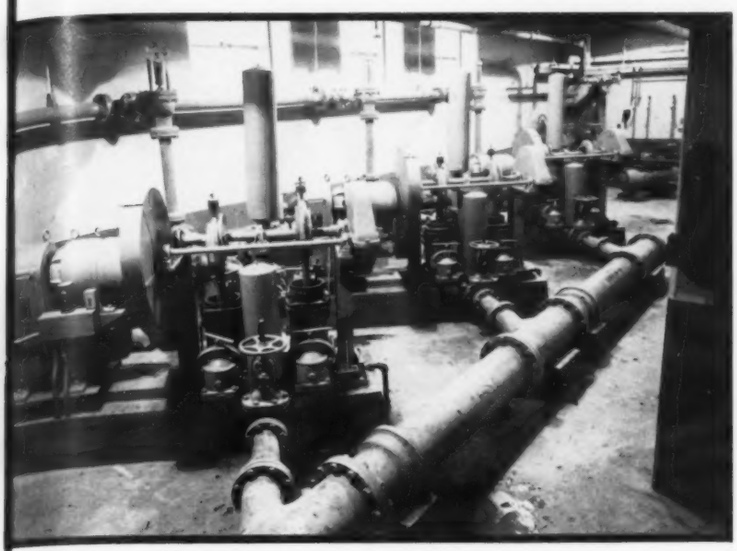


Figure 9 — Pumps remove sludge from the processing basins, returning it to the city disposal plant.

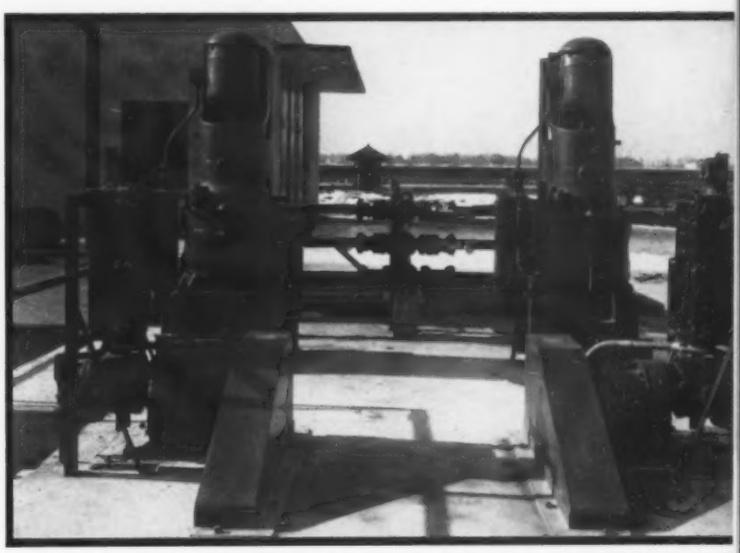


Figure 10 — Flash mixers provide rapid mixing of alum and chlorine.

plant of a present normal capacity of 35,000,000 gal per day was installed, designed primarily to process trickle filter water but so arranged that water from the activated sludge plant could be treated or by-passed through this plant. The by-passing arrangement should make it possible to keep the treatment plant sweet during warm weather, at times when trickle filter discharge is not being used. Venturi meters measure the discharge from the activated sludge plant and from the trickle filter plant to the steel company system. Facilities are provided to receive alum or lime by truck, in bags or in bulk. The chemicals are discharged into receiving hoppers from which they are elevated to overhead storage receiving bins. All receiving hoppers, the elevator and the storage bins are exhausted by a dust collecting system. The chemicals then are fed through dry feeders, mixed with water and injected into the influent as it enters the processing plant. Just ahead of the point where the chemicals are added are provisions for applying chlorine, for pre-chlorination. Rapid mixing of the alum and chlorine is accomplished in flash mixers consisting of rotating paddles on vertical shafts. The water than flows in parallel through two processing basins, passes through flocculators rotating on horizontal shafts to clarifying basins in which the floc settles out. Scrapers operating on the conical bottoms of these basins gradually work the deposit of sludge to the discharge pipe in the center of the cone from which it is exhausted through pipes by reciprocating sludge pumps located in the treatment house basement. Sludge is then pumped to the city sludge handling plant. Screens on the outlet of the clarifying basin serve to skim any floating material from the surface. Water leaving this basin flows by gravity and mixes in a head basin with any activated sludge discharge that may not be passing through this treating plant. Additional chlorination is provided at the point where the waters are mixed. Figures 4 to 13 inclusive show the details of this installation.

Figure 11 — Close-up showing flocculators which rotate on horizontal shafts, thoroughly mixing sewage and chemicals.

Figure 12 — Treatment basin, showing flocculators and plant building in background.

Figure 13 — Scrapers operate on the conical bottoms of the clarifying basins.

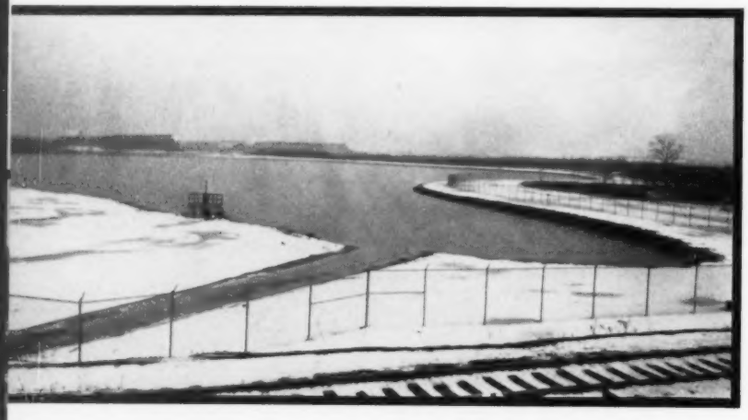


Figure 14 — Storage reservoir, with steel plant in the distant background.

Figure 15 — A high head pumping station at the reservoir supplies water to the steel plant.

The effluent from this plant flows by gravity with a total head differential of only 13 ft through a 60 in. reinforced concrete pipe line, all portions of which are below the hydraulic gradient, for a distance of 24,000 ft to a shallow reservoir adjacent to the steel plant in an arm of Humphreys Creek which has been dammed up to provide a storage basin of 74,000,000 gallons capacity. (Figure 14) The intention is to stop taking water during short intervals of high chloride content and to draw on the stored water in this reservoir during such periods. A by-pass has also been provided to allow cleaning or repairing of the reservoir. Adjacent to the dam is a high head pumping station (Figures 15 to 18 inclusive) equipped with one 10,000 and two 15,000 gpm pumps, and with traveling screens to trap leaves or driftwood, suction sump, duplicate chlorinators, automatic cone valves for flow regulation and non-shock check valve control, and a venturi meter for recording the total flow. Chlorine is fed to give a residual of 0.35 ppm at the pump discharge.

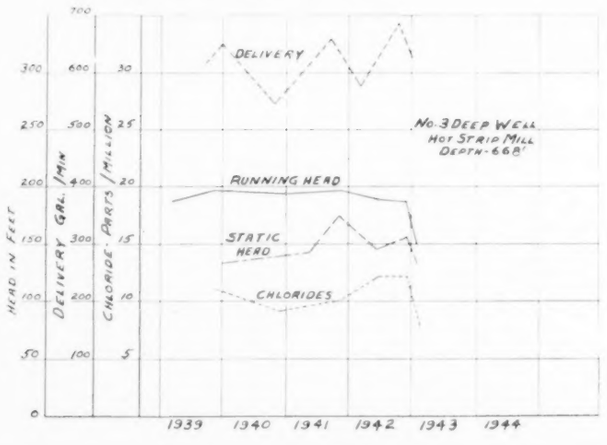
From this station the water flows through reinforced concrete and cast iron lines of graded sizes to all parts of the steel plant under an initial pressure of 55 psi which is kept balanced and equalized by a 750,000 gal capacity overhead stand pipe at the approximate distribution center of the system.

One of the most important considerations in such an undertaking was to insure that no possible contamination could result in any of the drinking or sanitary services. To this end an entirely new industrial water distribution system was installed, having no physical connection of any kind with the sanitary water system. In cooperation with the State Board of Health, suitable markings were established for sanitary and industrial systems so that they could be clearly identified.

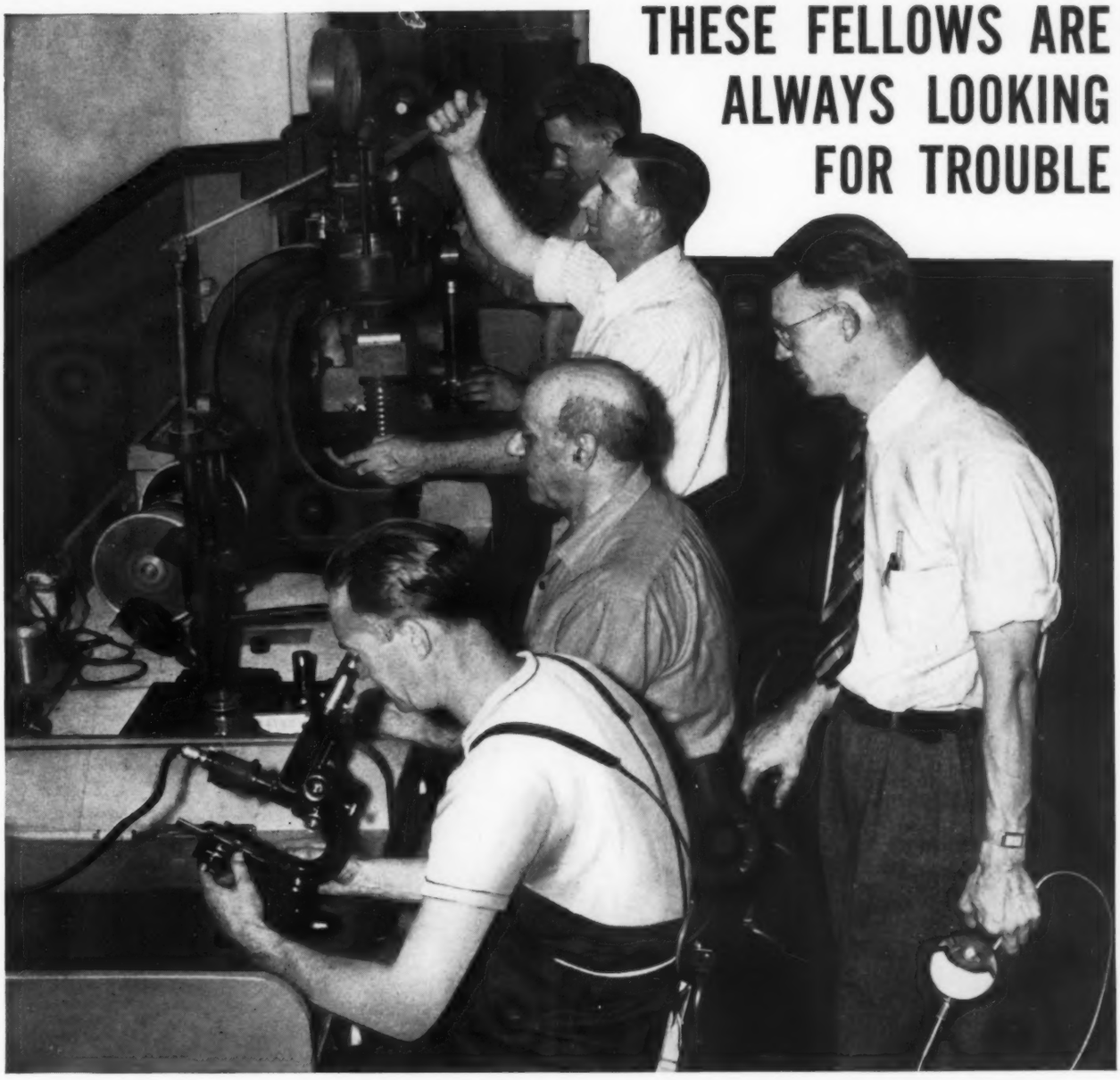
The system was placed in operation early in December 1942 and is regularly delivering an average of 24,000,000 gal per day of clear, treated and chlorinated water admirably suited for industrial uses. Results during January 1943 show the following:

(*Please turn to page 88*)

Figure 19 — With reduced pumpage from artesian wells resulting from the reclaiming system, ground water conditions show improvement.



THESE FELLOWS ARE ALWAYS LOOKING FOR TROUBLE



—so they can prevent it! They're the "watch dogs" of our Heat Treating Processes, where good bearings get off to a good start. Theirs is a roving commission, *re*-checking the checking done by the regular inspectors—to make doubly sure each step of the Heat Treatment of Hyatt Roller Bearings produces perfect results.

'Round the clock, 'round the year, they're on the job, looking for trouble—to save *you* trouble. They've worked out a series of continuing tests covering every phase of Heat Treatment. Some are repeated every 15 minutes, others several times an hour—some take only several seconds, others several hours. All are important...as is every test in precision bearing manufacture.

So important, in fact, that one out of every 6 Hyatt employes devotes his time to testing and inspection in various stages of manufacture.

Sound like a lot of work? It is—but worth it when you remember that more than 90% of all Hyatt Roller Bearings made today go directly into fighting equipment or the machinery that helps build it.

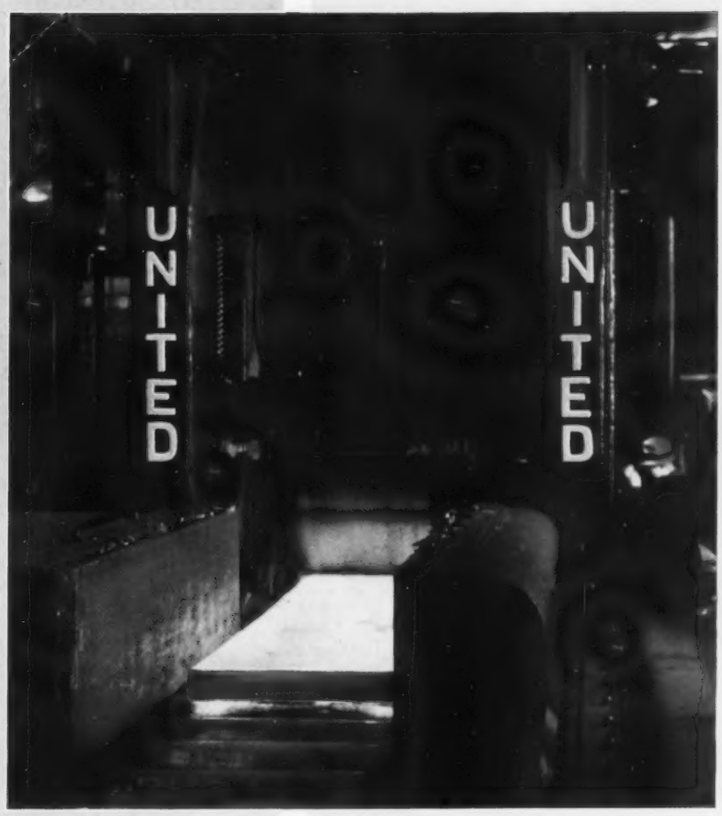
That's why we've *got* to make 'em good. Because Victory is our Business.

Hyatt Bearings Division of GENERAL MOTORS CORPORATION, Harrison, N. J.

Pave the Road to Victory with War Bonds

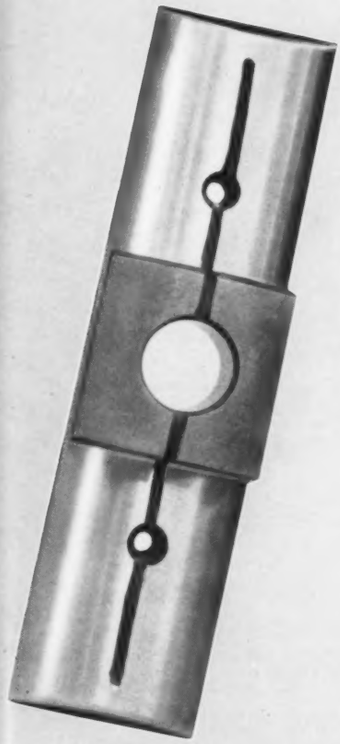
HYATT BEARINGS DIVISION OF GENERAL MOTORS

THE TOOL STEEL GEAR & PINION CO



. . . THE BLOOMING MILLS

must be kept going full blast to keep Hitler's stooges moving in reverse.



And that's where "TOOL STEEL" Gears, Pinions, Screws and Hardened Products are doing their bit

They're tough and just don't break down on the hardest kind of a job, and as for wear—well, years are for them what days and weeks are for ordinary products.

INSTALL "TOOL STEEL" Hardened Products and forget about stoppages and maintenance costs. Write for bulletins. We've plenty of proof in actual records showing what "TOOL STEEL" Products have done and are doing.

TYPICAL "TOOL STEEL" HARDENED PRODUCTS

Crane Gears • Brake Wheels
Crane Wheels • Table Bevels
Herringbone Mill Pinions • Screw Down Screws & Nuts

CO. . . . CINCINNATI, OHIO

Figure 16 — The high head pumping station contains one 10,000 and two 15,000 gpm pumps.

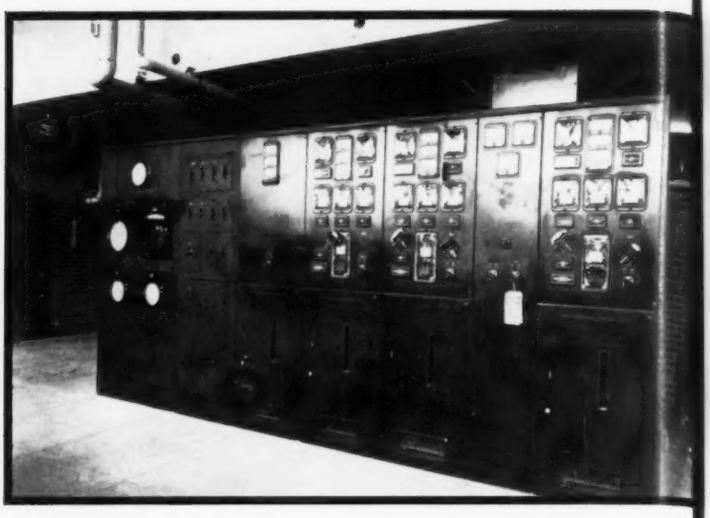
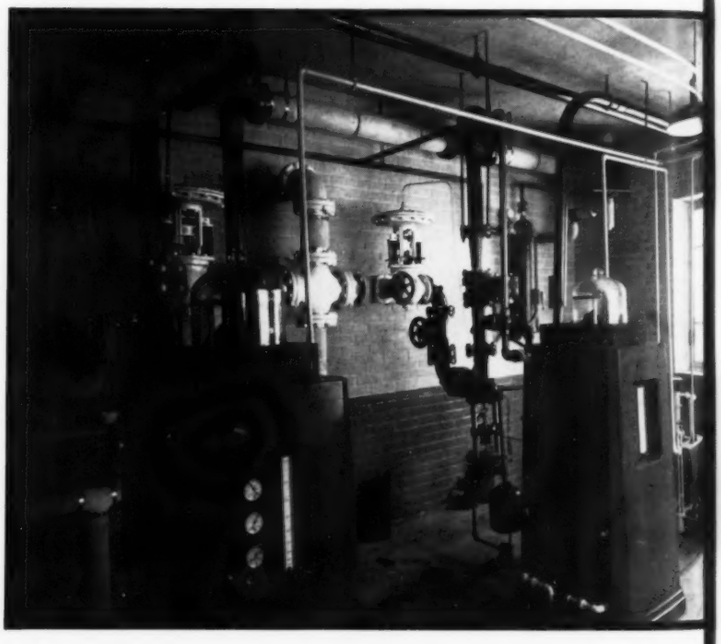


Figure 17 — Control panel at the high head pumping station.

▲

Figure 18 — Chlorinator equipment provides a residual of .35 ppm at the pump discharge.



Residual chlorine (at end of line)	0.25 ppm
Chlorides	80 to 120 ppm
Turbidity	5 to 12 ppm
pH	6.9
B. O. D.	7.0 and less

Free of odor except for a trace caused by the residual chlorine.

Under test conditions the system has been operated at full gravity flow capacity, at a rate of flow of 49,000,000 gal per day.

An interesting, and anticipated, development resulting from the reduction in the pumpage from artesian wells has been an immediate raise in the static head of the underground strata as well as an indication of a slight improvement in the quality of the water. This is illustrated in Figure 19. Future months will tell the story more fully, however. We hope that we will be able to preserve and restore enough of the underground water to insure a permanent, adequate sanitary and boiler water supply.

DISCUSSION

PRESENTED BY

N. D. KENNEY, Whitman, Requardt and Smith, Engineers, Baltimore, Maryland

J. L. HELLMAN, Steam Department, Bethlehem Steel Company, Sparrows Point, Maryland

W. P. HILL, Steam Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

H. L. NELSON, United States Pipe and Foundry Company, Philadelphia, Pennsylvania

L. L. JENNE, Sanitary Engineer, Department of Public Works, City of Philadelphia, Pennsylvania

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

H. D. ESTERLY, Power Engineer, Alan Wood Steel Company, Conshohocken, Pennsylvania

NORMAN D. KENNEY: The storage reservoir dam and access roadway is most unique, and has had more diversity per dollar of expenditure than any other job with which I have had contact.

First, it seems appropriate to discuss the design phases. After due consideration of initial and operating costs it developed that all agreed that a storage reservoir and pumping station near Sparrows Point would be most satisfactory. At this time I cannot go into the relative figures on gravity flow versus pumping characteristics and cost, the relative value of a high head pumping station being near the source of maintenance of all types, including guards and other phases of protection and control; but agree we did.

Fortunately there was a body of tidal water that lent itself to such a development. The North Cove of Humphrey Creek seemed ideal. The first thought that occurred to us was "How can we develop and make water-tight the proposed reservoir?" Our first thought was a dynamited earth fill of very good quality. Then we canvassed other alternatives:

Rock fill or slag fill dam
Concrete masonry dam
Ordinary earth fill dam
Steel sheet piling with clay fill.

Finally, with due regard to foundation conditions and critical materials, we all decided on the dynamited fill dam. We knew that it could be made water-tight with a steel sheet piling core wall if it were found necessary. In view of the fact that head differentials are relatively small we felt that chances of this sort were justified.

It was a fundamental that we have support for the discharge pipe from the high head pumping station. Also we had to have an electric power supply, water supply and an access roadway. Pile bents for the discharge pipe were considered but that left all other utilities stranded. So it was decided to make a dynamited fill for these also. This saved approximately three miles between Sparrows Point and the pumping station.

As developed we have pulled ourselves up by our bootstraps. Earth from the present reservoir volume was used to make the fill for the dam and access roadway.

The weather was sufficiently bad so that poor progress was made, when compared to calendar days. Another contractor came on the grounds for the adjacent high head pumping station and his work was delayed because of the danger of dynamiting muck next to freshly poured concrete.

A considerable number of borings over a large area assisted in the location of the dam and roadway. While bids were being taken the field forces made rod soundings of silt depth at 50 foot centers. These, in general, confirmed our previous information.

Trees and brush were cleared. Top soil was used to fill some low lying spots and also stored for future use. The underlying clay was excellent material for the proposed fills.

Earth was hauled onto the dam and access road until a height sufficient in the opinion of our consultant had been reached to allow the dynamited fill to fall in its final resting place. Consolidation of the fill was done entirely by a bulldozer that spread the earth in shallow layers and the trips of the "carry-alls."

Test soundings were made through the fill to determine the remaining thickness of silt. These soundings were made 20 feet on centers and cross sections plotted. From these data our consultant computed the dynamite charges.

Dynamite charges were placed at 20 foot centers over the area to be shot. Side shots were timed to go off a fraction of a second ahead of the center shots.

These side shots moved the adjacent muck and silt so that center shots would have some place in which to be relieved. The superimposed earth mass blew up in the air in a body and the impact of falling upon the muck and silt was great enough to consolidate and bond bond with it so that the conglomerate is all of equal capacity to resist water movement.

Some statistics on the reservoir are:

Maximum width	1400 ft
Maximum length	1950 ft
Area	41 acres

As to the whole project we believe that a good job has been done in a unique field. Wild ducks by the hundred or more are using this reservoir for winter quarters. The next question is whether bass and trout will exist in these waters. If so, a dual purpose will have been served; the Bethlehem Steel Company will have a satisfactory source of industrial water supply and my friends at the same place will have a private hunting preserve.

J. L. HELLMAN: My part in the problem of conditioning the industrial water at Back River for delivery to the Bethlehem Steel Company Sparrows Point plant was the inspection of Baltimore City's sewage system and the location of the infiltration of the harbor water into the sanitary system of Baltimore.

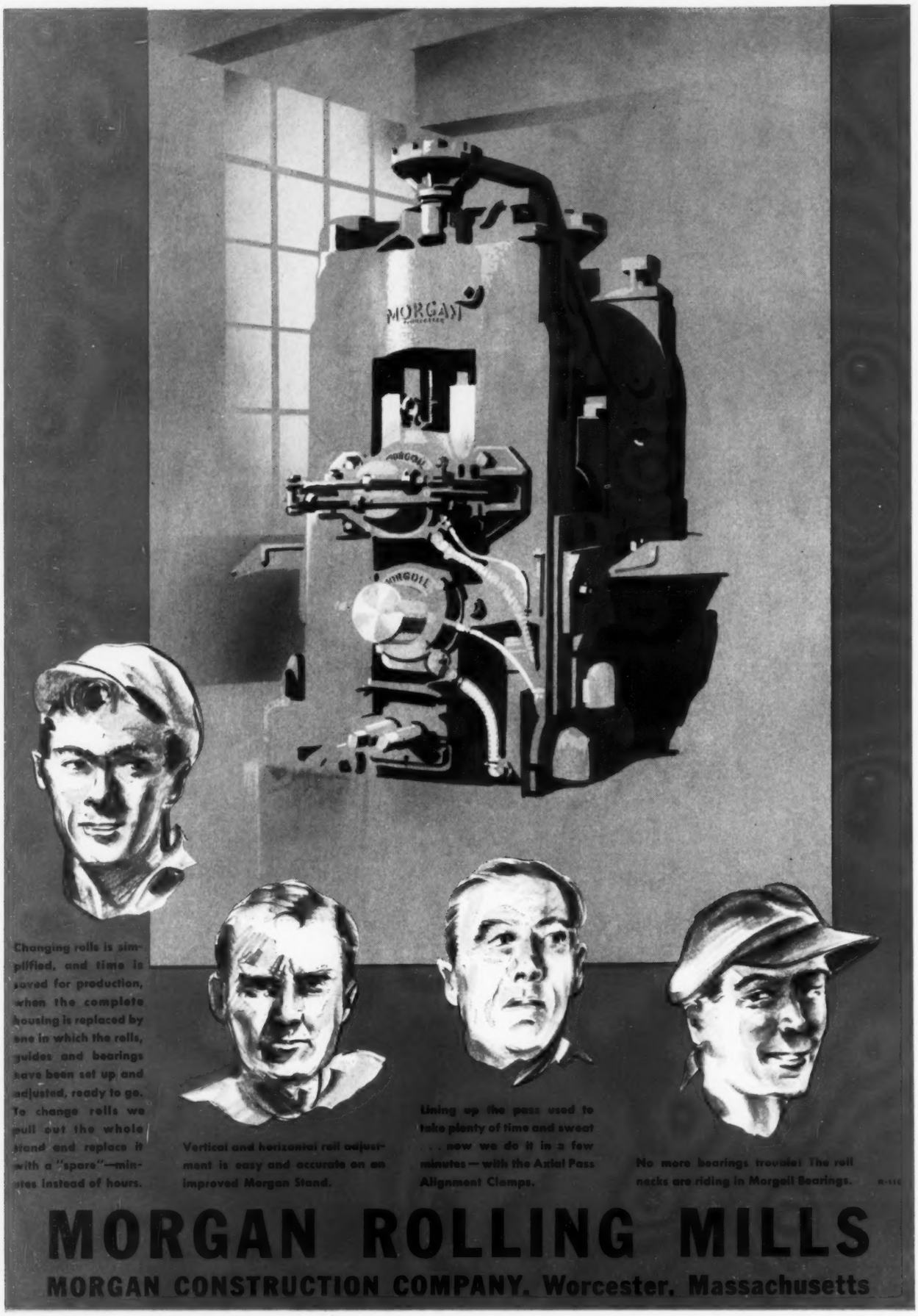
On studying the blueprints of the Baltimore sewage system it was found that the system was divided into two general areas: the high level area and the low level area.

The high level area is mainly domestic sewage with a chloride concentration of 40 ppm. The sewage from this area flows to the Baltimore treatment plant by gravity.

The low level area is situated around the north and middle branches of the Patapsco River. It is in this area that the entire sewage system is from three to ten feet below mean tide water. The majority of the industrial section of Baltimore city is located in the low level area. The sewage from the low level area is raised by pumping at the Eastern Avenue station and discharged into the main gravity interceptor at Chase Street. It was in this low level area that the high chloride sewage was found and the chloride concentration in this area at the pumping station varied from 175 ppm to as high as 300 ppm. By plotting tide level versus chloride concentration of the sewage in this area, it was found that the chloride varied directly as the tide. This gave evidence that the contamination of the sewage with chloride was from the infiltration of the harbor water whose chloride content averaged 3000 ppm. Sampling of the sewage at various manholes along the interceptor and testing it with standard silver nitrate solution, we were able to isolate the infiltration of the harbor water into the sewer between manholes by recording the increases of chloride concentration in the sewage.

A procedure was found for sampling the sewage along its path of flow and in the same direction as the flow. A sample of liquid was taken at each manhole along

(*Please turn to page 93*)



Changing rolls is simplified, and time is saved for production, when the complete housing is replaced by one in which the rolls, guides and bearings have been set up and adjusted, ready to go. To change rolls we pull out the whole stand and replace it with a "spare"—minutes instead of hours.

Vertical and horizontal roll adjustment is easy and accurate on an improved Morgan Stand.

Lining up the pass used to take plenty of time and sweat . . . now we do it in a few minutes—with the Axial Pass Alignment Clamps.

No more bearings trouble! The roll necks are riding in Morgoil Bearings.

MORGAN ROLLING MILLS

MORGAN CONSTRUCTION COMPANY, Worcester, Massachusetts

IN TIME OF ~~PEACE~~ WAR PREPARE FOR ~~WAR~~ PEACE

HORACE
SATIRES, BOOK II

FIFTY-ODD YEARS B.C., old Horace counseled the people in time of peace to prepare for war.

If he were alive today—when a whole world fights, and whole countries are forced into total war economy behind the fighting men — Horace would be the first to see that his famous axiom works both ways.

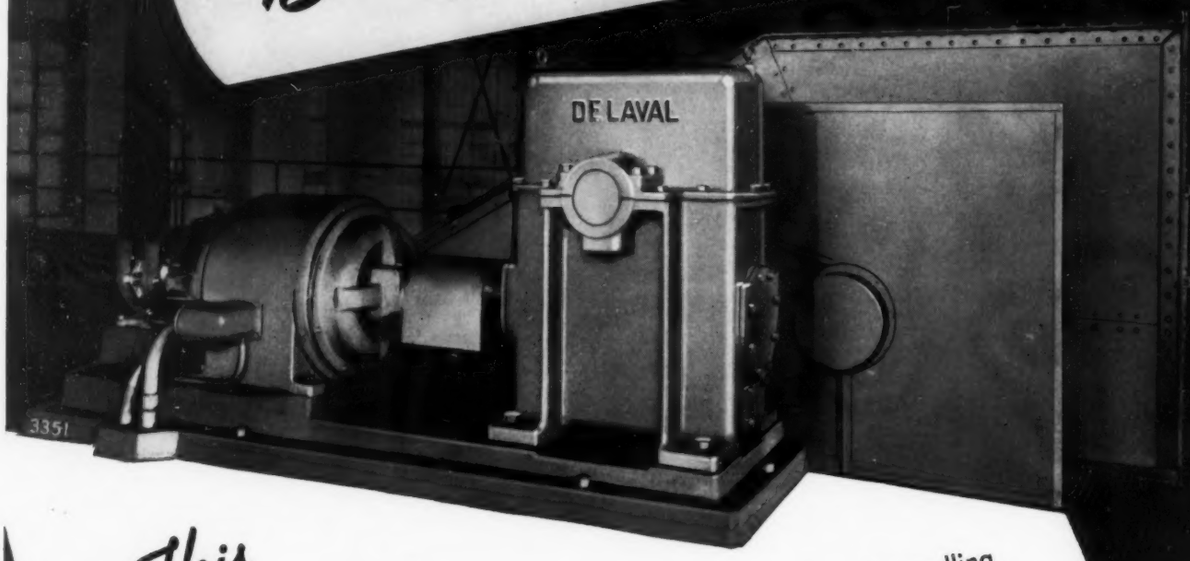
How can Union Steel's men of science help *you* prepare for peace? They're the men, you know, who pioneered the amazing method of combining cast and fabricated parts called "Fabricasting". They're responsible, also, for such forward-looking products as "Univan," the new, tough steel, and the Web-Spoke driving wheel center for locomotives.

Might it not be that their metallurgical "know-how", practical casting experience and progressive outlook could help you look ahead?

UNION STEEL CASTINGS Division of Blaw-Knox Company Pittsburgh, Pa.

Makers of driving wheel centers ★ locomotive frames ★ pump casings ★ vault doors and frames ★ annealing boxes ★ spindles ★ coupling boxes ★ open hearth charging boxes ★ gear blanks—and other steel and alloy castings for steel mills and general industry.

LONG-CONTINUED SATISFACTION *Brings Repeat Order!*



This
DE LAVAL
WORM GEAR of 32½ ratio was installed in a coal handling plant in 1928 to transmit 40 hp. to drive an apron conveyor.

Recently the owners bought three more De Laval worm gears, two of them for conveyor drives.

Continuous operation in an atmosphere laden with abrasive dust or moisture has no terrors for a De Laval gear, which is self-contained and self-lubricating and requires no attention further than an occasional checking of the oil level.

Process plants find in mechanical conveyors with De Laval worm gear drives a superior and economical means for moving materials steadily in large quantities over long distances.

Our engineers will be glad to study your requirements and to assist with data and layouts. Ask for Publication W-1133.

DE LAVAL **WORM GEAR DIVISION**
of the De Laval Steam Turbine Co., Trenton, N. J.

MANUFACTURERS OF TURBINES STEAM HYDRAULIC PUMPS CENTRIFUGAL PROPELLER ROTARY DISPLACEMENT MOTOR MOUNTED MIXED FLOW CLOGLESS SELF PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS GEARS WORM HELICAL and FLEXIBLE COUPLINGS

the pipe line. A sudden increase in the sewage chloride concentration between manholes readily showed that the harbor water was leaking into the pipe line.

As the distance between manholes in the city's sewage system varies from 300 feet to 400 feet, we were unable to locate the exact points of leakage.

In order to explore the pipe line along its entire length, a small electrode which floats on wooden blocks was made. The electrode was fastened to 500 feet of double conductor rubber covered cable. The cable was wound on a small hand operated reel. The conductors were connected to an alternating current Wheatstone bridge by means of slip rings mounted on the reel housing. The power for the equipment was supplied by an automobile battery. An electronic inverter was used to change the d-c to a-c.

By using the above described equipment, we were able to determine the exact location of the high chloride infiltration into the sewage. This was done by taking conductivity readings every five feet along the pipe line. As the chloride in the sewage increased the conductivity increased. This method proved very successful in locating points of infiltration of the harbor water into the sewage lines.

W. P. HILL: As Mr. Coffin explained to you there is no question but that many plants will be faced with the same problem we were faced with, and when that problem comes you can gain a lot of information, I believe, from the work we have done. We now know of two plants which have been operating as we have, but as you all know, each water has different qualities and has to be treated in a different manner. So, if you decide on treating any water, it means you have to develop your own equipment and tests, and conduct them over a considerable length of time to see that there are no bugs to be ironed out.

Of course we ran tests on every type of coagulant we could locate. If somebody told us some sort of ore would work, we tried it; we tried practically everything, but we decided that a sure cure was alum, so we set in the equipment and started treating the plant with alum.

When we originally started this, the bauxite situation was not as critical as today — in that day for the same price it was running around 21 per cent of available aluminum. Today you pay the same price when it is running around 15 per cent aluminum, and the reason for that is bauxite available for water treatment must come from local fields around Georgia and Virginia, etc., and the good grade of bauxite must go to aluminum manufacturing industries.

We originally thought of treating the water with four grains of alum per gallon. When using a straight alum we often run as high as five or six grains, in order to give a good clean water.

We now use an activated alum and have averaged for the past month 4.2 grains per gallon.

The other treatment, chlorine, has played a very important part. We use chlorine for killing the bugs, as you might say, and in our treatment plant I believe it is quite evident we will have to use chlorine to keep that from gassing up. As you know, some of the partially treated sludge will turn sour, as they say, in a few hours in the sunshine, but with chlorination we can hold that down. Of course, we have been operating only in the winter months — we can control it in the winter months, but next summer we will find our real test of what we can do. This water is very high in ammonia, and you know, with the ammonia there it is going to help a great deal. It has helped us a great deal and we are not using as much chlorine as we had originally planned on.

H. LLOYD NELSON: I have been following this job since its inception and have discussed it several times with several people. I believe that at one time they found an unusual amount of chloride when testing the water in the Baltimore sewers. It turned out to have occurred after a flood and some time later, on investigating conditions, it developed that one company used salt in processing and the flood had washed through the building where the salt was stored and they found the exact amount of chloride in the sewage corresponding to the amount of salt washed away by the flood.

Water, I might say, is a critical material. I am temporarily one of the consultants down at the Water Division of the WPB, and it might be of interest to know that if we have a dry spring and summer the water situation may become more critical than it is at present in some places, and we are preparing the necessary legal authority to go in and ration water on any particular system.

We are also preparing a limitation order on the drilling of wells to prevent the situation arising in other plants that has already arisen at Sparrows Point. We find people drilling wells indiscriminately around the country and drawing down ground water levels.

LYLE L. JENNE: Approximately how much does it cost to treat the sewage exclusive of pumping?

L. F. COFFIN: Our problem is to continue our close supervision and control during the warm months. We know it can be done. It may take a different technique from that we are using today, but we have the facilities and the organization to do the job.

As to the underground water study that Mr. Nelson referred to, incidentally, the State of Maryland has appropriated money for full-time study of underground water and its contamination, and our situation at Sparrows Point together with that of other large industries at Baltimore is one of the impelling motives behind it.

As to the temperature of the water — a minimum of 38 F has been reached, delivered to the plant, this winter, and the maximum will probably be around 80 F. The maximum of the sewage disposal plant water has been 80 F. Well water has run 60 F or thereabouts, so we will have a few more problems in cooling in warm weather — but of course, 60 F cooling water is unusual. Anyone getting water from a stream is going to get the same temperature water we will get.

There will be less deposit in the lines. We are already scouring out the lines and hope to get improved results from that point of view.

As to cost of treating, outside of pumping, I am not prepared to give those figures as yet.

H. D. ESTERLY: What becomes of the sludge they take out?

L. F. COFFIN: The station is arranged so that the sludge can be pumped to the Baltimore sludge disposal plant at Back River. They recover large quantities of sludge from their operation and this installation is arranged so that they will dispose of it for us.

Saved $19,000 in Power

Saved 200 Tons of Bearing Metals

Increased Production 375 Tons per day

Saved $4400 in Oiling Time

Saved $3260 on Lubricants

Eliminates Frequent Mill Adjustments

Saves Men —Prevents Accidents

Farval . . . on Modern Soaking Pits and Blooming Mills

By injecting the grease directly between the bearing surfaces in exact quantities and at regular intervals, Farval maintains a proper film of lubricant at all times—giving a free-running mill—eliminating the need for frequent adjustments and permitting a faster and hotter rolling of steel.

Twenty-four hour operation leaves you no time margin for shutdowns—either to lubricate, or to repair if you *fail* to lubricate. To keep your "Steel for Victory" schedules rolling, you must keep your bearings rolling too.

Eliminate Mill delays—increase daily tonnages—*install Farval!*

In Canada:
PEACOCK BROTHERS LIMITED

The Farval Corporation • 3278 East 80th Street, Cleveland, Ohio

Affiliate of The Cleveland Worm & Gear Company, Automotive and Industrial Worm Gearing

WHAT LUBRICANTS . . .

Where?

An ever-present problem on which Houghton can help

Steel mills have long since passed through the era when oil was "just oil". They have lubrication engineers whose job it is to lick the trouble-spots and to train men to lubricate intelligently so as to prolong the useful life of massive machines.

Those men know, for the most part, how science has been able to improve on nature through the fortifying of good oils to enable them to protect metal surfaces from wear. How important lubrication is to the mill can be seen by examining the pages of this publication filled with discussion on this vital subject.

Houghton's place in lubrication may be described as "specialists on a volume basis". Some of these applications where Houghton "fortified" lubricants are doing a fine job are listed at the left.

Our technical services to diagnose lubrication troubles and suggest remedies—based on more than 70 years in the business of improving on natural petroleum stocks—are freely available. Write—

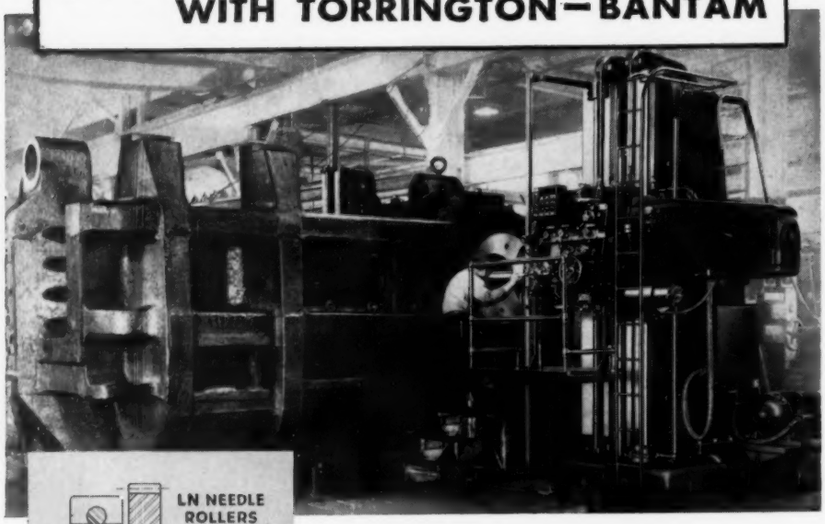
Ask about
HOUGHTON LUBRICANTS FOR THESE USES:

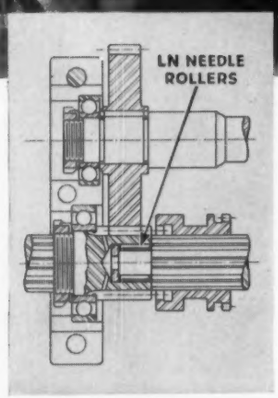
Hand Guns and pressure systems
Roll Necks
Open or closed housings
Transmissions
Mill Reduction Gears
Roller Bearings
Worm Drives
Mill Screws
Heating Furnace Cranes
Cover Journals
Table Bearings
Manipulators
Mill Pinions
Runout Tables
Flying Shears

E. F. HOUGHTON & CO.
PHILADELPHIA
CHICAGO · PITTSBURGH · DETROIT

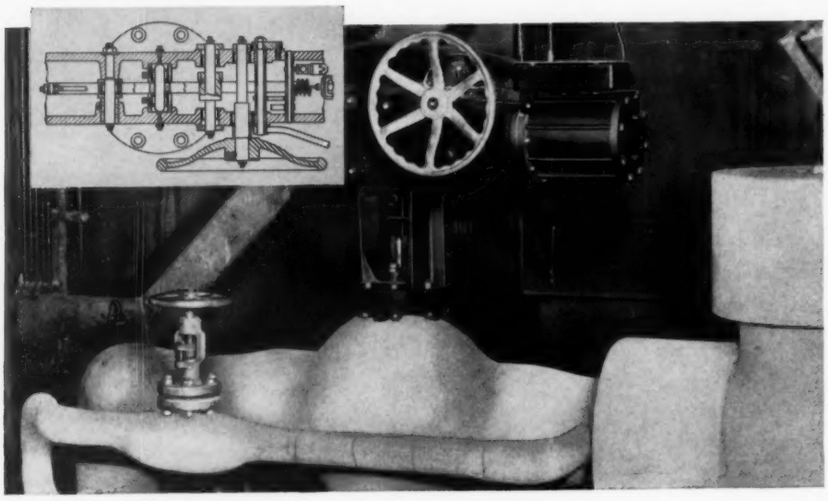
HOUGHTON'S *Fortified* OILS and GREASES

IN THE NEWS
WITH TORRINGTON—BANTAM

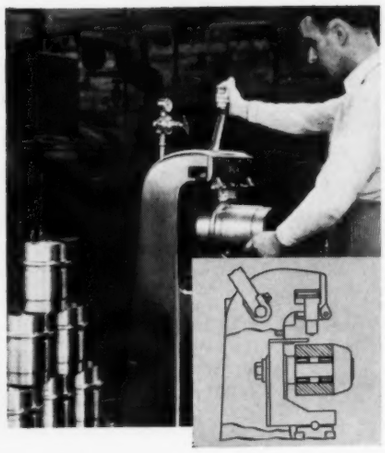




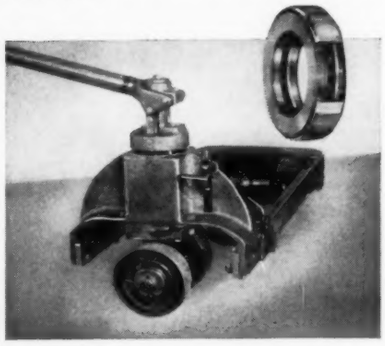
MACHINING GIANT CASTINGS to precision limits is simplified by this 6-inch spindle, floor-type horizontal boring, drilling and milling machine manufactured by The Ohio Machine Tool Company. 44 Type LN Needle Rollers, which are used as the pilot bearing of the transmission, as shown in the accompanying cross-section, contribute materially to the smooth, stable and precise performance of these finely engineered milling machines. Needle Bearings in all types and sizes from one-quarter inch to over seven inches in diameter for virtually all needs are available from Torrington. Our engineers will be glad to help in the selection of the type to meet your requirements.



WATER FLOWING AT HALF-TON PRESSURES through an 8-inch pipe is controlled by this three element feed water control valve made by the Bailey Meter Company. The valve is part of the control system of a modern high pressure boiler which serves a 60,000 kwh turbine in an electric generating plant. As shown in the accompanying cross-section, Type NCS Needle Bearings assure dependability and ease of operation for which this valve is noted. Further information on Needle Bearings is available on request.



MARKING ROUND OR FLAT SURFACES, precision graduating and serial numbering are the accomplishments of this versatile Pneumatic General Purpose Marking Machine built by the Noble and Westbrook Manufacturing Company. The worker shown here is marking part numbers on finished aircraft engine cylinder barrels, while the cross-section shows the mandrel support which holds the work. A compact, high capacity Type NCS Needle Bearing carries the mandrel to provide ease of rotation.



MATERIALS HANDLING with manual equipment is aided by such modern items as this liftruck manufactured by the Revolvator Company. Unusual maneuverability is made possible by the free 360° swing of pump and pulling handle, which is designed for anti-friction operation through use of a Torrington Ball Thrust Bearing in combination with a Type DC Needle Bearing.

IF YOUR NEED IS FOR LARGE BEARINGS, Torrington-Bantam's experience in the design, application and manufacture of outsize bearings is of special value. Or if you have a bearing problem which appears to call for special treatment, the experience of Torrington engineers in the design and application of every major type of anti-friction bearing suggests that you can profitably TURN TO TORRINGTON for expert counsel.

ARMY (E) NAVY

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

Serving Well!

ON THE HOME FRONT

ON THE BATTLE FRONT

"NATIONAL" Brushes are serving well with our armed forces and with industry at home. While the immediate demands of the emergency come first, every effort is being made to give all our customers the service to which they have been accustomed. When ordering "National" brushes observe these precautions to insure prompt delivery.

1. Anticipate your needs and order as far in advance as possible.
2. Give complete and accurate information on your original purchase order. Include samples and drawings when necessary.
3. Secure best possible priority rating.

NATIONAL
TRADE-MARK
CARBON, GRAPHITE AND METAL-GRAPHITE BRUSHES

LET'S GO! U.S.A. KEEP 'EM FLYING!

The word "National" and the three pyramids symbol △△△ are trade-marks of National Carbon Company, Inc.

CONSERVATION AND CARE WORK HAND IN HAND

In the present emergency it is particularly essential that your electrical equipment be kept running constantly and at full efficiency. Proper cleaning and elimination of minor faults will do much toward accomplishing this objective.

The Modern Pyramids Bulletins pictured above give practical suggestions on care and maintenance of brush-using electrical equipment. They are available to you without charge.

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
CARBON PRODUCTS DIVISION, CLEVELAND 1, OHIO
General Offices: 30 East 42nd St., New York, N. Y.
Branch Sales Offices: New York - Pittsburgh - Chicago - San Francisco

Meet the Equipment Manufacturer

UNITED
ENGINEERING and FOUNDRY COMPANY

Text by JOE MALBORN

Herewith is presented the sixth in a series of articles outlining the history and development of the many companies servicing the iron and steel industry. It is felt the progress of the equipment manufacturer has been so closely allied with the upward march of the steel industry that our readers would be interested in the many developments sponsored by the manufacturer which were so helpful to the industry. In later issues this series will be continued.

PURDY PIX

▲ Like nearly all of the giant iron and steel, engineering and kindred industrial companies, our company's beginning was as small as the tiny spring, lake or rivulet starting maybe high up in some mountain region, but which by taking into its bosom, as it winds its way along its thousands of miles journey to the sea, many other rivulets and streams until it becomes a mighty Mississippi or an Amazon, and empties itself into the ocean and from thence its waters are spread across the face of the whole earth bringing to countless millions of people many of life's necessities, and furnishing the necessary machinery and instruments for producing those necessities, food, clothing and the many thousands of small and large domestic appliances that make life worth living, and which above all have done so much to give the world's busy housewife and mother and her family many, many more spare hours of leisure in which to enjoy the better things of life and which, thank God, is putting an end to root causes of such poems as Thomas Hood's "The Song of the Shirt," and may it be ever thus.

Although United Engineering and Foundry Company as it now stands, in *name* at least, dates back a mere forty-two years (it was organized as United Engineering and Foundry Company in 1901), its component parts, go back just about a whole century, and if we include our British associate component, The Davy and United Engineering Company Limited of Sheffield, England, our foundations were laid about some 113 years ago, when two brothers David Davy and Dennis Davy started out on their own in 1830 in Pear Street, Sheffield, England.

Looking at our start in these United States of America, it is usually a matter of friendly argument and contention between two of our components as to which one was born first. Our Lloyd Booth brother at Youngstown, Ohio claims that he first saw the light of day in the year of our Lord 1849, although from later information that has come to our notice, it is not at all unlikely that the original founders, Parmalee and Sawyer, were both in the foundry business

K. C. GARDNER — president — born in Cleveland, Ohio — received education there at University School and Case School of Applied Science — began career with Wellman, Seaver, Morgan Company — became associated as sales engineer with The Lloyd Booth Company, Youngstown, Ohio, in 1899 — in 1901 when this company was consolidated with other companies to form United Engineering and Foundry Company, he came to Pittsburgh as sales engineer — later elected director, and 1928 was made vice-president — in 1929 was appointed manager of machinery sales, in 1934 placed in charge of all sales — assumed additional duties of general manager in January, 1943 — in July, 1943 became executive vice-president and general manager, position held until appointment as president.

with other and older concerns before they started out for themselves in 1849. However, reliably, we take 1849 as the authenticated birth.

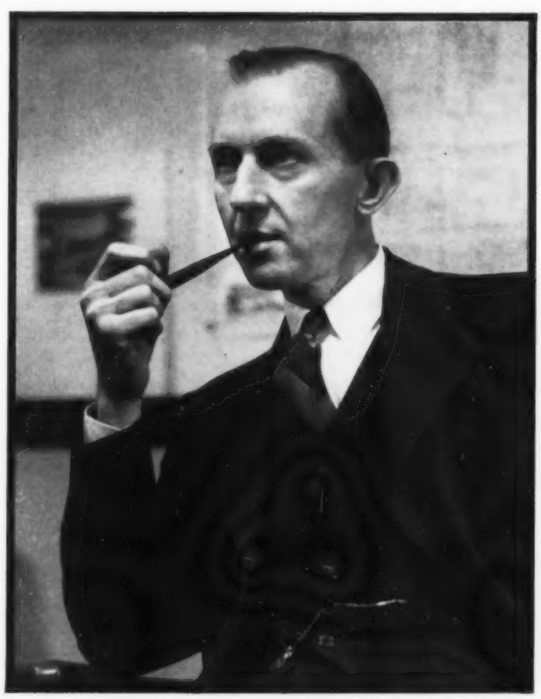
Our Vandergrift foundry lays claim to have been born at Apollo, Pennsylvania, some four miles up the Kiskiminitas River from Vandergrift in the old Canal Days and this reference places its natal day in the middle of the nineteenth century. We have, however, authentic records only as far back as 1887 in which year it was absorbed into the old Apollo Iron and Steel Company. A Mr. Casper Kettering, who operated the old foundry before its absorption was retained as manager.

The old original foundry, as was the case with the old Lloyd Booth foundry was undoubtedly interested at first mostly in castings for agricultural implements for the farmer and stoves for the homes and stores of the

WILLIAM HAGEL (left) — manager of machinery sales — graduated from Carnegie Institute of Technology night school in mechanical engineering — joined United in 1917 and held positions of estimator, chief estimator, and assistant to sales manager before his appointment as manager of machinery sales.

GEOFFREY G. BEARD (right) — vice-president in charge of sales engineering — born in Scotland — graduated from Royal Technical College — won Montgomery Neilson Prize in 1926; also James Riley Medal for original research offered by West of Scotland Iron and Steel Institute — in 1926-27 was employed as research engineer by Safety and Mines Research Board, London — came to United States in 1927 and employed by United as draftsman, later engineer — in 1935 became sales engineer and manager of proposal department.

JOHN L. YOUNG — vice-president in charge of industrial research — University of Indiana — joined United in January, 1936 as service engineer — within a few months became manager of machinery sales — in November, 1941 apointed project manager, charged with formation of DPC aluminum sheet rolling mills at Trentwood, Washington — having completed this project, returned to Pittsburgh — appointed vice-president in charge of industrial research — before joining United he was employed by Timken Roller Bearing Company as draftsman, development engineer, district manager and assistant general manager of industrial division.



F. C. BIGGERT, JR. — chairman of board — born in Crafton, Pennsylvania — graduated from Western University of Pennsylvania in 1899 — became associated with Frank-Kneeland Machine Company, Pittsburgh, which company became incorporated with United in 1901 — continued to serve the company in its engineering department — in 1906 was made assistant chief engineer, and in 1913, chief engineer — was elected second vice-president in 1915, and in 1919 elected president and general manager, which position he held until 1928 when he became chairman of the board.

early settlers, and then as the iron industry grew and expanded they both branched out into machinery and rolls for the then rapidly growing iron and steel and copper and brass rolling mill industry.

This old Apollo foundry was moved to Vandergrift in 1901 and was known as the Chilled Iron Roll Foundry Company and was purchased by United in 1902.

However, if I were called upon to act as referee on the longest life I am afraid I would award the palm to our Lloyd-Booth plant.

Heading the United sales group, reading from left to right, are William Hagel, manager of machinery sales; Horace Mager, manager of roll sales; Geoffrey G. Beard, vice president in charge of sales engineering; John L. Young, vice president in charge of industrial research.

Next in line as regards age is our William Tod plant also at Youngstown, Ohio. Actual records available date this plant's birth about 1856, but here again we are told very reliably that there was a plant operating on the same site many years prior to 1856, but as we have no actual records we take 1856 as the natal day of the William Tod Company although we have circumstantial evidence that the plant may antedate Lloyd-Booth Company by many years.

This William Tod plant specialized in the building of blowing engines for blast furnaces, steam engines for all manner of rolling mills, pumps of all descriptions and general machine shop work, and from this plant and the old Lloyd-Booth shops and foundries have come some of the largest and finest rolling mills in the world such as, for example, the mighty 210 in. 4-high plate rolling mill built for the Lukens Steel Company at Coatesville, Pennsylvania, the 98 in. continuoushot strip and plate mill for Republic Steel Corporation at Cleveland, Ohio, the first and still the largest semi-continuous plate mill in the world, the Homestead, Pennsylvania, 100 in. mill of the Carnegie-Illinois Steel Corporation, a subsidiary of the United States Steel Corporation, which was also mostly completed, as far as the actual machinery goes, in this plant.

The fourteen thousand ton steam hydraulic forging presses for Midvale Company, and the Charleston Navy Yards were machined and completed in Youngstown, and I should add, in our Frank-Kneeland plant at Pittsburgh, Pennsylvania (but more of that when we come to this member of our family). Let me add here that the huge steel castings for these giant mills and presses were all cast at our Vandergrift steel foundry.

The next member of our family as regards age, but now also deceased and departed, although its products are still part of our present day manufactures, pipe mill machinery and rolling mill equipment, was the old McGill plant at Pittsburgh, Pennsylvania founded in 1885 by Messrs. J. J. McGill, William Manchester and Charles E. Satler. Mr. Satler is still an active member of our Board of Directors.

Next comes our Frank-Kneeland plant at Pittsburgh, Pennsylvania, founded in 1892 as the Frank-Kneeland Machine Company by Messrs. I. W. Frank, Edward Kneeland, William Metcalf, J. J. Donnell, John W. Chalfant, Samuel Frank, Abe Frank and J. H. Purdy.

This old plant stands on the very ground connected with Stephen C. Foster of "Old Black Joe" and other negro songs, and of course its history will always be connected with that grand negro song composer. Many of those songs were given birth to on that property.

From this plant, still going strong, has come its full share of all the great rolling mills and presses and a thousand other things that go into the iron and steel and non-ferrous rolling mill industry, and this plant works in close harmony and conjuntion with all our other shops and is just as important.

Next in line was our Lincoln plant, also at Pittsburgh, founded in 1894 by Messrs. Otis H. Childs and William M. Abbott. Associated with these men were Mr. James Kirkwood, Mr. G. G. Small and Mr. G. W. Knotts. Mr. Knotts is still an active member of our Board of Directors.

From this plant has come some of the finest cast iron chilled rolls known to the trade, and the Lincoln roll came to be a byword in the sheet and tinplate mills and other rolling mills. This plant operated until a few years ago.

The next one of our family to be born was our American Roll Foundry Company, born in 1906 at Canton, Ohio, and its first president was Mr. J. B. Baird, and Mr. William Gardner as vice-president .The company was reorganized in 1908 and the present manager, our Mr. John Quinn, became superintendent.

From this splendid cast iron chilled roll foundry goes some of the largest and smallest rolls in the world, the huge rolls for the Lukens 210 in. mill and the tiny experimental mills in several laboratories are made in this plant. There is scarcely a rolling mill in this country and many foreign countries that does not draw its rolls from this plant.

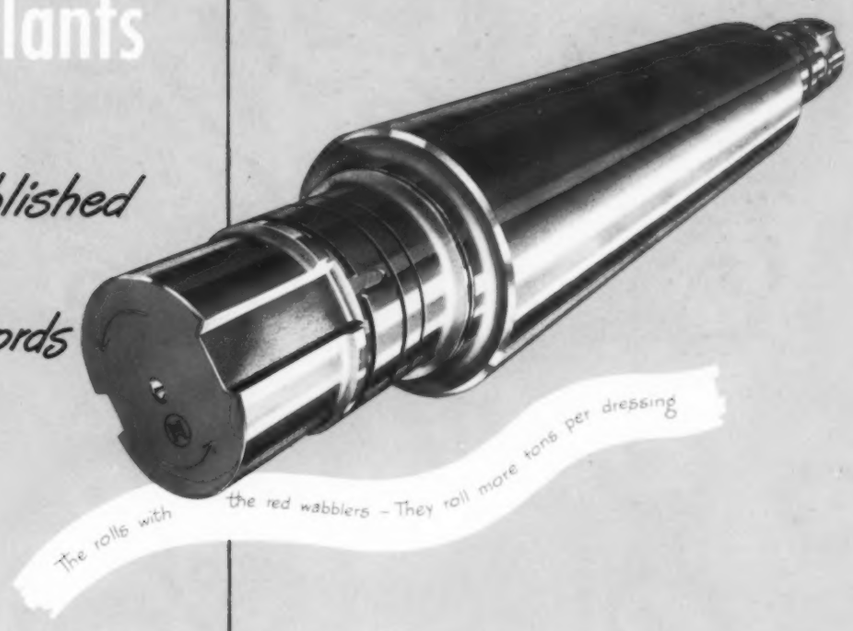
Our last born brother and a very lusty one at that is our huge plant at New Castle, Pennsylvania, started in April 1942 and completed in January 1943. This huge plant comprising four open hearth furnaces, steel foundry for castings up to 200 tons each,

Ol' Red Wabbler says:

Nironite C Rolls in four steel plants

have established

outstanding tonnage records



reduced costs

In four of the Nation's great steel plants Nironite C Rolls, on continuous mills, have established new records in finishing flats, small strip bars and hoops. Operating men prefer and select them above all others.

There are reasons. They are high nickel chromium of the grain or indefinite chill type. They have increased resistance to spalling. They give better finish and greater tonnage per grind. Their body structure very closely approaches that of true chill and the bodies and centers and necks are soft and strong.

You can get the most for your roll dollar — specify Mackintosh-Hemphill Nironite C Rolls.

Other Mackintosh-Hemphill Products:

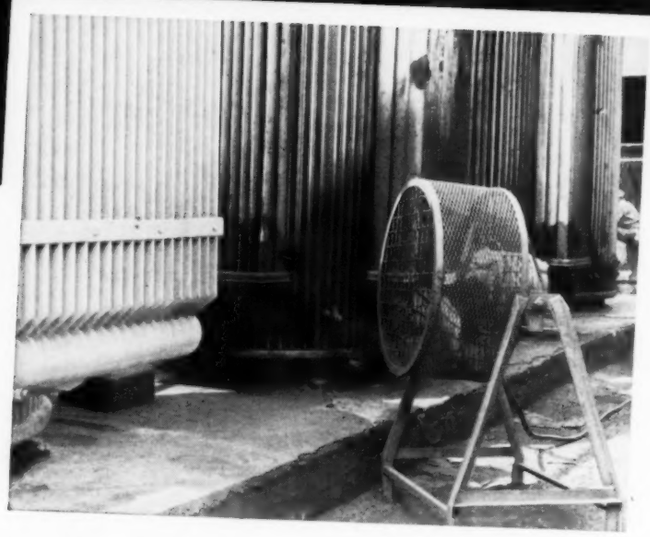
Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron-Steel Castings . . . The NEW Abramsen Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes.

MACKINTOSH-HEMPHILL COMPANY—Pittsburgh and Midland, Pa.

Let *Truflo Fans* . . .

Help keep your workmen on their toes

Portable Fan No. TF-100, recognized as standard in many of the country's largest mills. Sizes from 12 in. to 36 in. in diameter.



Portable Fan No. TF-300 in operation, cooling large transformers in strip mill.

Crane Cab Fan, for cooling crane cab interiors and other confined areas. Available in 12 in. and 18 in. sizes, adjustable both horizontally and vertically.

Portable Fan No. TF-300W. Angle iron support adjusts for vertical or horizontal discharge through almost 360°.

It's more important now than ever before to keep your workmen comfortable. For comfortable workmen are more efficient, produce more work in a given time.

Truflo Fans can help you keep your workmen on their toes. All Truflo Fans are designed and built correctly for efficient, economical operation — they move more air per dollar. Write for free literature on any of the following styles:

Portable Cooling Fans • Crane Cab Fans
Wall Fans • Exhaust Fans • Blowers
Roof Ventilating Fans • Pent House Fans

TRUFLO FAN COMPANY

554 MAIN STREET HARMONY, PA.

forge shop with a 1500 ton steam hydraulic forging press, welding and fabricating shop, and machine shops represents just about the last word in its particular field.

In 1937 we entered into a working arrangement with the Davy Brothers Company at Sheffield, England and the name of this company was changed to The Davy and United Engineering Company, Ltd. This British concern, founded in 1830, was really the founder of the forging press industry, and as early as 1885 they began to develop the heavy hydraulic forging press and later the steam hydraulic press as it is known today all over the world.

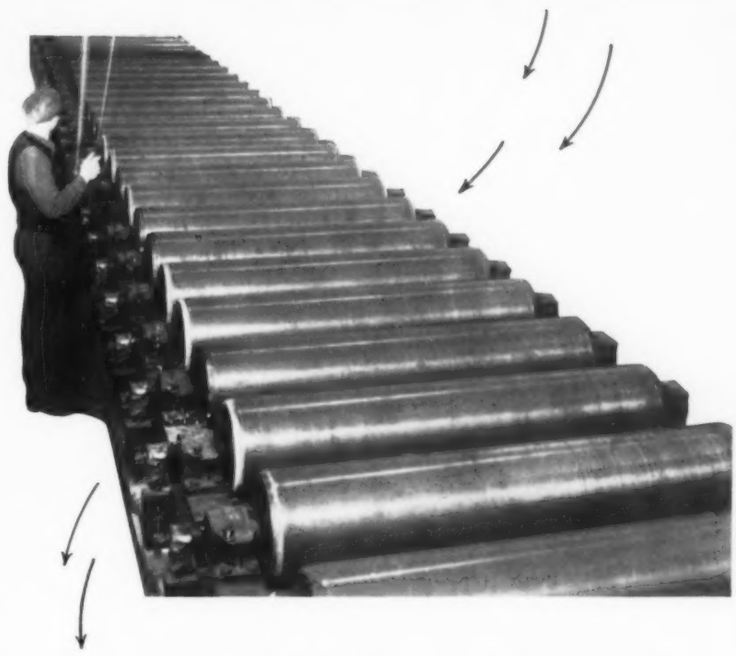
The Dominion Engineering Company of Montreal, Canada was the next to come into working arrangements with United. This Canadian company is truly one of the most progressive and aggressive engineering firms in the world, and from their splendid modern shops in Montreal and other towns and cities of Canada goes out to the four corners of the earth some of the finest rolling mill machinery ever designed and built, forging presses, stamping presses, steam, gas and Diesel engines, pumps, rolls and all the necessary auxiliary equipment for all metal rolling.

Together with our associated companies we have encircled the globe with iron and steel and all the nonferrous metal rolling mill equipment and auxiliaries, and it is with great pride that we can honestly say the sun never sets upon "United's" equipment.

The center of all this activity is right in the heart of Pittsburgh, Pennsylvania. Here starts the designs and engineering and the tedious but necessary research work that never ceases.

From these older companies the presidency of Mr. I. W. Frank and his associates, many of whom are still active, and the traditions of those old firms are still being carried on in the way those old pioneers would have wished, by our newly appointed and well loved chairman Mr. F. C. Biggert, Jr. and our genial president and general manager Mr. K. C. Gardner. Both of these gentlemen have given at least half a century of work to the company at one plant or another of the family.

These men are being followed now by several "youngsters" who will in their turn take up the torch when it is handed to them, and carry on the great traditions of the company.



START - STOP - REVERSE
Simplified with
SCHLOEMANN "Motor-Rollers"

★ Shear, scale, or mill tables requiring unusual start-stop-reversing service attain the maximum in mobility and ease of handling when equipped with Schloemann "Motor-Rollers." The rugged squirrel cage motor enclosed in the roller permits flexibility of movement with a minimum of time and effort. The free turning shell housing the driving motor permits each "Motor-Roller" to act as an idler roller when the current supply is disconnected. Space-consuming line shafts, gear reduction units, and couplings are eliminated. This simplicity of construction gives the additional advantage of free access along both sides of the table, a distinctive feature of Schloemann "Motor-Rollers."

★ *Hydraulic Presses* ★ *Accumulator Controls*
★ *Air-Hydraulic Accumulators*
★ *Engineering of Complete Hydraulic Systems*
★ *Extrusion Presses*

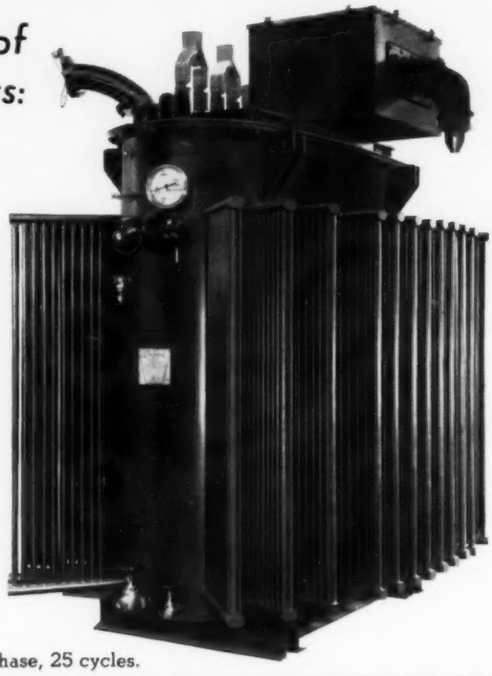
SCHLOEMANN
ENGINEERING CORPORATION
1102 EMPIRE BUILDING . . . . . PITTSBURGH, PA.
HYDRAULIC PRESSES • ROLLING MILL MACHINERY

For convenience and economy of transformer installations indoors near the load centers

Ask for Askarel

Pennsylvania's noninflammable, non-explosive, liquid-filled transformer

Check these outstanding qualities of Pennsylvania Askarel Transformers:



3000 kva, ASKAREL, 3 phase, 25 cycles.

Circular Coils Possess Maximum Inherent Strength

In regular oil-cooled transformers, varnish is used to increase the mechanical and electrical strength of the transformer coils, irrespective of the shape of the coils. This kind of varnish, however, cannot be used to treat coils in a transformer where noninflammable liquids are employed. Therefore, without the aid of this varnish, it is imperative that the coils in a noninflammable transformer have great inherent strength. Pennsylvania circular coils possess the maximum inherent mechanical and electrical strength!

Radiators Built to Withstand High Pressures

Askarel transformers develop high pressures inside the tank because of the sealed, pressure-tight, tank construction necessary to prevent loss of Askarel through evaporation. Sturdy Uni-Row radiators on Pennsylvania Askarel transformers are designed to meet these high pressures. As rugged as the tanks themselves, these radiators are premanently welded in position and tested at 100 lbs. pressure. Radiators are spaced around the tanks so that each tube of each radiator is easily sandblasted, cleaned and painted.

Self-Reclosing Safety Valve Relieves Excessive Pressures.

Safety valves are mounted on the covers of all Askarel transformers above 25 kva, and operate in case abnormal pressures exceeding 12 pounds per square inch develop inside the tanks. These safety valves are self-reclosing to prevent foreign matter from entering the transformers.

333 kva, ASKAREL, 1 phase, 60 cycles.

25 kva, ASKAREL, 1 phase, 60 cycles.

Pennsylvania TRANSFORMER COMPANY
PITTSBURGH, PENNSYLVANIA

Pennsylvania TRANSFORMERS

- Since Askarel Transformers are noninflammable and nonexplosive, they may be installed indoors at the load centers without a vault or fire door.
- Since Askarel is nonsludging and nonoxidizing, and the transformer tanks are pressure-tight and moisture-proof, Askarel transformers may be installed outdoors as well as indoors.

OLD STUFF TO YOU, MAYBE. But New to Many Green Hands

If you are an oldster in the steel business, you know how to keep overhead cranes in tip-top condition but your help may not be as experienced as you are. Therefore, we publish the following check list with the hope that it will aid you in training your crews and, at the same time, help the inexperienced to learn their job faster and better.

How to Maintain an Overhead Crane

The familiar "Stitch in Time Saves Nine" applies particularly to overhead cranes. Regular maintenance and checking, which sometimes requires a few minutes shutdown, may prevent a breakdown during a peak production period, costing several hours.

Alliance Cranes are built to move heavy loads efficiently. They are sturdily constructed, easily operated, and have many advanced features. But proper maintenance assures longer and better service, just as regular checking keeps your car on the road more years Here is the guide list:

1. Regular lubrication at all points, including hoisting ropes, as specified in our Lubrication Manual.

2. Periodic inspection for tightening of loose parts and replacement of worn parts.

3. Regular cleaning of commutators and slip rings of motors—refacing as they become worn. The brushes, contacts, controller fingers, should also be cleaned or replaced if they have become pitted or burned.

4. Proper adjustment of brakes at all times.

5. Testing of limit stops at beginning of each working period.

6. Complete knowledge of crane mechanism and proper care by operator.

Never before has it been so necessary to keep cranes on the job. Without cranes, round-the-clock production would be slowed to a walk and we cannot afford to let that happen now.

Alliance

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS
SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET
CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES

ARMY E NAVY

THE ALLIANCE MACHINE COMPANY • ALLIANCE, OHIO

NATIONAL ROLLS

EACH ROLL A CAREFUL STUDY

ROLL specification and composition vary in so many ways — scrap content, alloy blending and in specialized purpose in the mill, that each demands careful study in its making.

Over years of trial, success and error, details have been largely reduced to reliable, fundamental processes developed by the industry at large that have kept the strength of rolls generally consistent with the new pressure of steel production itself.

Thustonnage and uniformity of output are now common that would have been impossible only a few years ago.

NATIONAL ROLLS have drawn from, and contributed to, the legend and best methods of the industry and thus represent the best fundamental technique available, applied with all the skill at our command.

The NATIONAL
ROLL & FOUNDRY CO.

All Grades of Plain and Iron Alloy Rolls–Both Chill and Grain Types
Heavy Iron Castings and Rolling Mill Equipment

AVONMORE, PA.

OHIO

Extra Strength MAGNETS

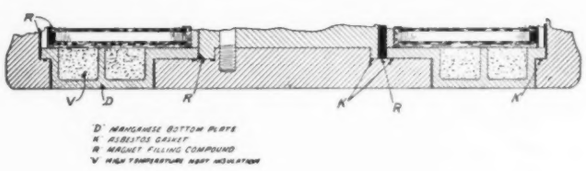
The OHIO 6 pancake coil magnet in the 55″ and 65″ sizes will lift 35% more material on the average than the standard magnet.

The 8 pancake coil 55″ and 65″ magnets will lift 75% more than the standard magnets.

Labor cost per ton and time required to handle are both reduced correspondingly.

One large steel company bought a 6 coil 55″ magnet. It has since bought 23 more.

★When Ohio magnets are required to handle hot materials we can supply them with hollow bottom plate. Hollow spaces are filled with heat resisting material. See cut below.



Such magnets can handle hot material all day.

Have you a fast lifting or hot lifting problem?

The OHIO Electric Mfg. Co.
5907 Maurice Avenue Cleveland 4, Ohio

Load All Bearings This Right-Angled Way

. . . and help check the decline in output-per-man-hour

ROLLWAY'S RIGHT-ANGLED BEARING LOADING

reduces down-time for service & replacement

Deterioration of equipment . . . loss of manpower . . . and cumulative labor fatigue . . . ALL are steadily reducing output per worker in war and civilian industry. Every help that can keep shifts operating at top efficiency . . . and machines running without shutdowns . . . is of utmost importance now.

● All radial loads carried at right angles to the roller axis.

● All thrust loads carried at right angles to the roller axis.

Cut Down on Shut Downs with Rollway Right-Angled Bearings

Rollway Roller Bearings wear longer . . . require less maintenance . . . and provide greater carrying capacity in given dimensions, because they *simplify* the load, *reduce* the pressures per bearing and per roller. Rollway splits every load into its two simplest components of *pure radial* and *pure thrust*. Each component is carried at *right angles* to the roller axis by *separate* bearing assemblies. No oblique loads and resultants, no thermal float or uncalculated thrust can impose secondary pressures on *any* Rollway Bearing.

Choose Your Bearings with Care

The torque and life of roller bearings are greatly affected by selection of the proper size and type. Send drawing or detailed description for free bearing analysis and recommendation. No obligation. S.A.E. or American Standard metric dimensions and tolerances available for most applications.

ROLLWAY BEARING COMPANY, INC., SYRACUSE, NEW YORK

BUILDING HEAVY-DUTY BEARINGS SINCE 1908 — BEARINGS

Hagan Control—

RELIABLE · STABLE · POWERFUL · ACCURATE · FAST

● When you think of regulating furnace pressure to a few thousandths of an inch water gauge, it is natural to associate such regulation with light, easily-moved dampers. This may be very far from the case, as is illustrated by a number of Hagan installations where large water cooled dampers on open-hearth furnaces presented the problem of moving unbalanced weights up to approximately 1½ tons through a stroke of 7 feet.

To accomplish this regulation, the Hagan spinning pilot valve and external relay produce a force amplification of 8,000,000 times. This in itself is remarkable, but of even greater importance is the fact that the amplification is achieved without appreciable loss of accuracy of the pilot valve.

The ability to produce *high amplification with accuracy* is an outstanding characteristic of Hagan Control.

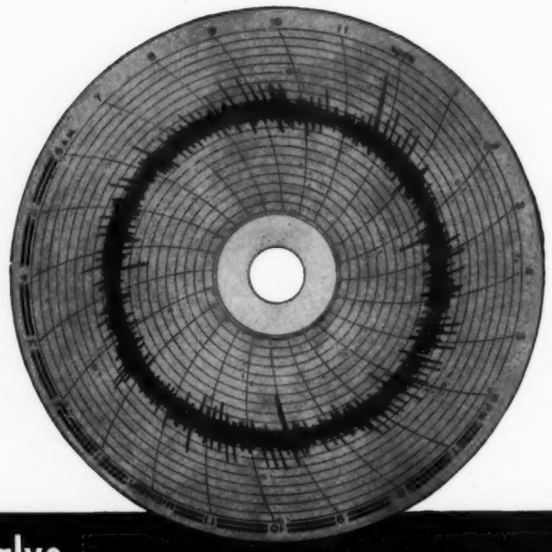
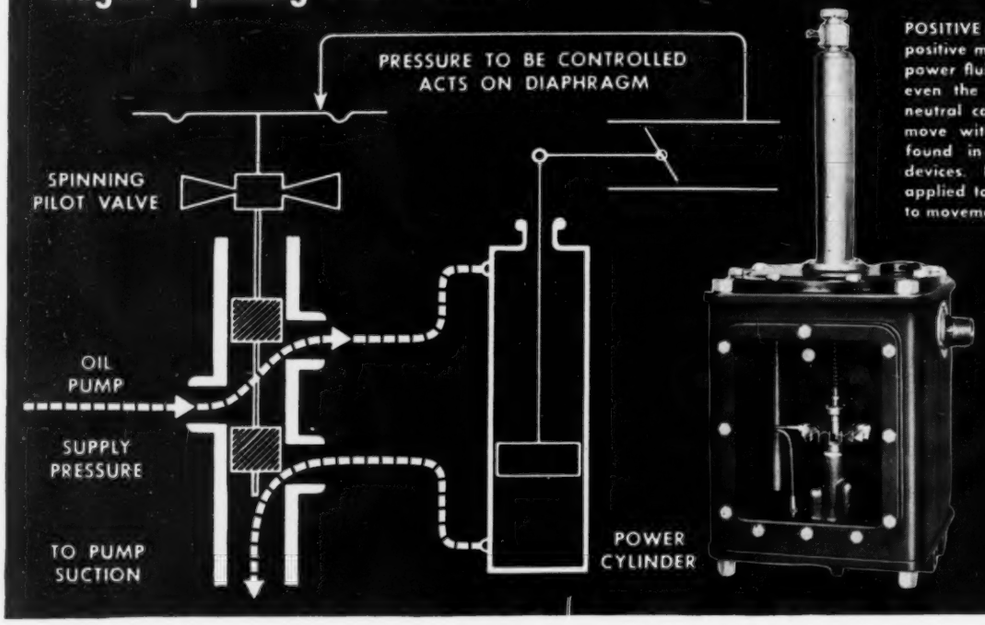


Chart taken from a tilting-type, open-hearth furnace tapping 185 to 200 tons per heat, fired by tar and equipped with a 3600-pound damper operated directly by an oil power cylinder having a 10 inch bore and a 7 foot stroke.

Hagan Spinning Pilot Valve



POSITIVE ACTION. With a direct positive mechanical passage for the power fluid from pump to cylinder, even the smallest deviations from neutral cause the Hagan piston to move with a precision not to be found in weaker forms of pilot devices. Full pressure is always applied to overcome any resistance to movement of the regulated valve.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH (30), PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

Efficient materials-handling with Exide-equipped industrial trucks helps ease manpower shortage!

Forked truck loading bagged materials into a railroad freight car. One man handles the work of many.

Forked truck stacking palletized unit load. This method doubles storage capacity of warehouses.

Production costs cut through increased efficiency

Efficiency must be today's keynote. Manpower shortages permit no waste motion or space, and fast-moving, battery-powered, industrial trucks mean big savings. They permit faster loading, unloading of materials . . . their use increases the effectiveness of every available man, and permits women to perform tasks formerly considered too heavy for them. Combined with modern methods of palletizing unit loads of almost every material, industrial fork trucks make possible higher stacking, with a consequent increase in vital storage space, and give you many important savings.

HANDLING OF PALLETIZED UNIT LOADS

Although many kinds of modern materials-handling equipment are used in efficient operations of loading and unloading, there are definite advantages to the palletized unit load. Here are some of them, using forked truck pallet and tractor-trailer systems of handling.

1. Handling-time cut 25-75%; particularly in unloading railroad cars and trucks.
2. Volume of damage reduced by elimination of many manual bucket-brigade handling operations.
3. Capacity of warehouses increased through higher tiering of palletized materials.
4. Enables use of less skilled help, including older men and women.
5. Simplifies inventory-taking, sorting, and inspection operations.
6. Reduces accidents, and often prevents them.
7. Makes rodent and vermin control simpler through better housekeeping methods.

The success of the war depends upon speedy movement of men and materials. Standardization of packing methods and materials-handling equipment accelerates the movement of materials at home and on the fighting fronts.

EXIDE-IRONCLAD BATTERIES OFFER THREE VITAL POINTS OF SUPERIORITY

- MORE POWER, MORE PRODUCTION: An Exide-Ironclad delivers its power at uniform voltage to assure constant hauling speeds. There is always a giant surge in reserve when an Exide powers your battery propelled vehicles.
- LONG LIFE SAVES MATERIALS: Every Exide is built to last, and saves vital materials by squeezing the last ounce of use out of the materials in it. When you buy an Exide, you definitely . . . Buy to Last and Save to Win.
- EASY MAINTENANCE, SAVES LABOR: Exides are kept charged by the simplest method ever devised. With the Exide Charge Control Unit all you do is connect battery to the charging source and turn a knob.

Exide
IRONCLAD
BATTERIES

DELIVERIES — Despite war-time conditions, we are quite sure that we can make deliveries to meet your requirements.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
Exide Batteries of Canada, Limited, Toronto

Tractor-trailers speed-up loading operations. Palletized loads can be placed on trailers by forked trucks, hauled to storage or shipping points and unloaded by forked trucks for additional speed and prevention of materials-damage.

for CONTINUOUS
TROUBLE FREE Resistor SERVICE

★ ALL STEEL CONSTRUCTION
★ MICA INSULATION
★ RUGGED TERMINALS
★ PROVISION FOR EXPANSION
★ ADEQUATE VENTILATION
★ UNAFFECTED BY VIBRATION
★ MOISTURE RESISTANT
★ CORROSION PROTECTED

Steel and Mica, the two basic materials entering the construction of P-G Steel Grid Resistors, are the foundation for continuous trouble free resistor service. P-G uses these materials in a unique design to provide both for expansion and for maximum ventilation. For more detailed information, ask for a copy of Bulletin No. 500

P-G

"The Resistor you can Install and Forget"

THE POST-GLOVER ELECTRIC COMPANY
• ESTABLISHED 1892 •
221 WEST THIRD STREET, CINCINNATI, OHIO

made to measure
for your individual needs

● Every Birdsboro "Special" Roll is individually "tailored" to the job it must perform. They are not made to meet general or average conditions. Each is engineered to its specific job —its analysis and physicals carefully planned for its purposes. That is why Birdsboro "Special" Rolls have such an outstanding reputation for giving longer roll life, greater tonnages and more rolling accuracy. If *yours* is a roll problem, it will pay you to consult Birdsboro.

For blooming mills, billet mills, structural mills, bar mills, rolling mild, structural shell, gun barrel, seamless tube and special alloy steels. Also for 4-high strip mill back-up rolls.

BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY • BIRDSBORO, PENNSYLVANIA

BIRDSBORO

ROLLS

Brushes Wearing Too Fast?

Inspect for these CAUSES

Most of the reasons for excessive brush wear are listed along side. Look for these conditions and correct them.

CHECK BRUSH RIGGING TO PREVENT BREAKDOWNS

It's wise to examine brush holders, shunts and brushes once a month. Holders should be replaced when the inside broached section is worn. Keep the shunts tight and free from corrosion. If the brushes themselves are giving you trouble, or you want to better their performance, write SPEER. We'll help you put the finger on what's wrong, tell you what brush grade is best for specific machines. This counsel is our boost to better commutation and its help in stepping up effective use of wartime power. Just ask for a SPEER Brush Data Form for every motor or generator you would like to improve. Fill in and return the forms for scientific recommendations based on forty-five years of commutation experience. Kindly write on your business stationery for any number of forms.

BACK THE ATTACK — BUY MORE WAR BONDS

1. Brushes too soft
2. Rough commutator
3. Abrasive dust in ventilating air
4. Off neutral setting
5. Bad commutation
6. High, low or loose bar
7. Excessive brush tension
8. Threading and grooving
9. Oil or grease from air or bearing
10. Motor kept on line when not used

SPEER
CARBON COMPANY

SCC

ST. MARYS, PA.
CHICAGO · CLEVELAND · DETROIT
MILWAUKEE · NEW YORK · PITTSBURGH

4689

WAGNER PRODUCTS
SPEED VICTORY
1000-KVA UNIT SUBSTATION WITH NOFLAMOL TRANSFORMER, 13,200 TO 480-VOLT, 60-CYCLE, THREE-PHASE.

Wagner

UNIT SUBSTATIONS

are doing their part in the production of steel, synthetic rubber, oil, and other vital materials

The Unit illustrated above is installed in a synthetic rubber plant. The transformer has a two-position liquid-filled disconnecting switch on the high-voltage side which is equipped with low-voltage interlock. The low-voltage side is equipped with air-break circuit-breakers electrically or manually operated, ground indication lights, voltmeters, ammeters, and ammeter test blocks. Unit has one main breaker, one tie transfer breaker, and four feeder breakers.

For Complete Information on Wagner Unit Substations write or phone the nearest Wagner branch office.

Wagner Electric Corporation

ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis, 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

T43-5

For Flexibility of Furnace Operation . . .

HIGH TEMPERATURES TODAY—

LOW TEMPERATURES TOMORROW—

BLOOM

Tempered-Flame

BURNERS

★ Provide uniform heating conditions

★ Avoid Large Temperature Differentials

★ Improve Quality of Workmanship

For general-purpose furnaces used in heat-treating, annealing, drawing, slow cooling, etc., Bloom TEMPERED-FLAME Burners provide controlled conditions for a wide variety of heating and cooling cycles.

For high temperature work, this burner provides all the advantages of long-flame combustion. When lower temperatures are wanted, excess air is introduced, heated and intimately mixed with the burning gas. This lowers the temperature without reducing the volume of gases, thus keeping the chamber at an even temperature throughout. Surprisingly low temperatures can be maintained, for this burner will stay lighted with 1000% excess air.

Perhaps Bloom TEMPERED-FLAME Burners will help you get better results. Write for full details.

BLOOM ENGINEERING CO.

857 W. North Avenue · · · PITTSBURGH, PA.

6 ADVANTAGES OF FARREL ROLL GRINDERS

Farrel Type TT Roll Grinders are equally capable of taking heavy roughing cuts or of producing a high mirror finish. On either type of work they are both accurate and fast. Many automatic features assure simplicity in setup and operation with only a minimum of skill required on the part of the operator.

The Farrel crowning and concaving device, which is built into these machines, is designed to produce the exact curvature desired without manipulation by the operator. A mathematically accurate curve, symmetrical on both halves of the roll, is produced for either a convex or concave shape. The same setting invariably produces exactly the same curvature and permits fixed, uniform and easily controlled accuracy of contour in all rolls.

A patented attachment for grinding tapered roll journals or tapered sections of heavy shafting can be incorporated in the machine when it is built, or added after installation. With this device a roll can be ground with tapers on both necks and finish ground on the body without disturbing the original setting of the roll. This guarantees a true roll in minimum grinding time.

Farrel Type TT Roll Grinders are available in four sizes to take maximum diameters of 20″, 24″, 28″ and 32″. In addition we also build a line of Heavy Duty Roll Grinders with traveling wheel carriage in six sizes to take maximum diameters of 24″, 28″, 36″, 44″, 50″ and 60″. Both types are made in any length required.

Write for descriptive booklets. Bulletin No. 113 gives details of Farrel Type TT Roll Grinders. Heavy Duty Grinders are described in Bulletin No. 111.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y. — Branch Offices: New York, Buffalo, Pittsburgh, Akron, Los Angeles

HYDRAULIC LIFT USED ON 6000 POUND TRUCK

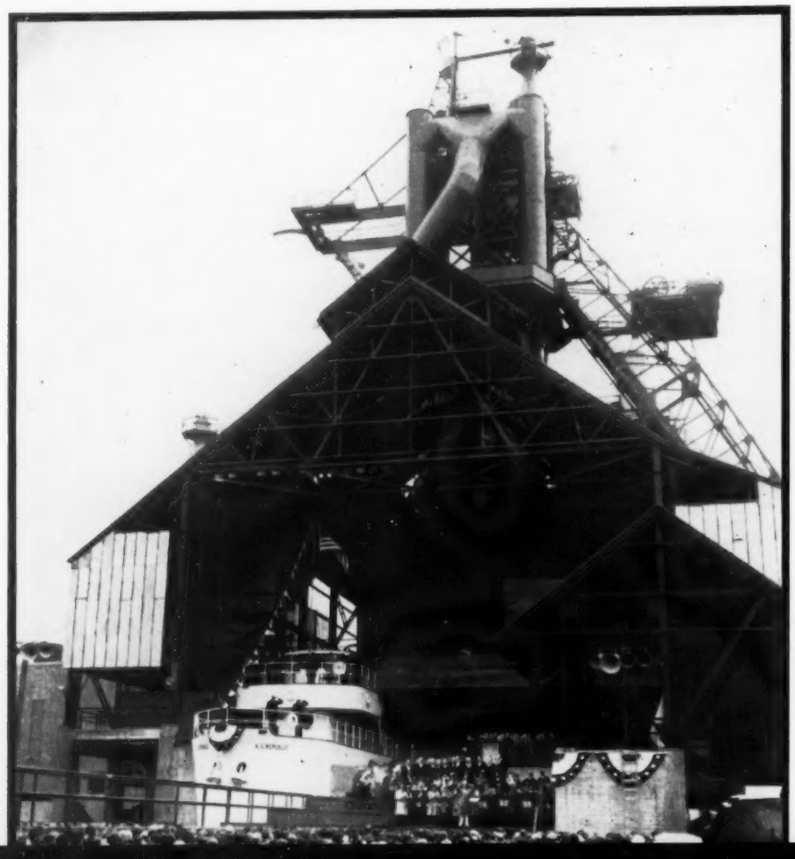
▲ A new 6000 lb capacity Hy-Lift truck, known as the type H-3, which is a companion truck to the type E-3 announced recently and can be used interchangeably in the same material handling system with it, has been announced by the Baker Industrial Truck Division of The Baker-Raulang Company. This new Hy-Lift truck combines the "self-loading" feature with tiering and is useful for both transporting and tiering skidded material.

The truck is built on a 66 in. wheelbase; the overall length, including the operator's guard, is 123¾ in. and the truck is designed for operation in intersecting aisles 67 in. wide. Its overall height of 83 in. permits ready entrance into box cars for loading and provides a maximum lift of 67 in. The platform is 26½ in. wide x 54 in. long x 11 in. high in the low position.

The battery box has been increased in size from 27 in. x 36⅝ in. to 32 in. x 39½ in., providing space for enough additional battery capacity so that the truck may be operated continuously on the longer shifts necessitated by the war emergency. Thus, under most conditions, there is no need to stop during a working shift to change batteries.

An improved and efficient hydraulic lift system provides positive control of hoisting and lowering. The control lever, convenient to the operator's right hand, starts the pump motor and closes the valve forcing oil into the jack cylinder. Lowering is by gravity controlled by the same lever. A limit switch shuts off the pump motor at the upper limit of platform travel with auxiliary safety through a

MARITIME AWARD ACCOMPANIES LIGHTING OF NEW BLAST FURNACE



Four thousand employees of Republic Steel Corporation's Cleveland district cheered the lighting of this 1300-ton blast furnace in double ceremonies Thursday, October 28th, when they received the Maritime "M" award in recognition for production achievements which have speeded the ship building program of the U. S. Maritime Commission. Rear Admiral Howard L. Vickery, vice-chairman of the Maritime Commission, made the award from the bridge of the "S. S. Republic," built for the occasion in the shadow of the furnace to symbolize the plant's record output of ship plate. T. M. Girdler, chairman of the board of Republic Steel Corporation, lit the furnace which was started in February, 1942, under a Defense Plant Corporation contract.

POWERED BY PHILCO "XL" BATTERIES, TRUCKS
HAUL 10% MORE MATERIAL!
IN warehouses . . . embarkation ports . . . war plants from coast to coast, electric industrial trucks are handling materials with outstanding speed and efficiency.
Every day, more and more truck operators are selecting Philco "XL" Batteries for new equipment or replacement because Philco-powered trucks will haul 10% more material!
Philco "XL" cells provide 10% extra capacity without increase in overall battery size!
If your trucks have a man-sized job to do, specify Philco Batteries! For complete information and specifications, write for latest Philco Industrial Truck Battery catalog. Philco Corporation, Storage Battery Division, Trenton 7, New Jersey.
ELWELL-PARKER
High Lift Platform Truck
Model ELN-6T
Typical Philco Industrial Truck Battery in Steel Tray
Replace with
PHILCO
BATTERIES
PHILCO

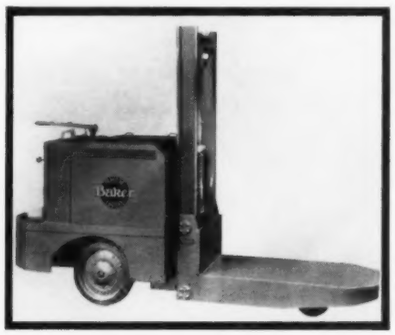
relief valve. The platform travels vertically on ball bearing rollers running in upright channel guides. The power is supplied by a single hydraulic jack and travel is compounded by sprockets and roller chains.

All controls, together with lift motor and pump, are in a convenient control panel and are readily accessible. The travel brake which is located just below the control panel is adjusted by a single hexagon nut which is out in the open where it can be readily reached.

The cover on the battery compartment is of the sliding type and is equipped with handles in place of hand holes. The front top corner of the compartment has been chamfered to give the operator better visibility assuring faster and easier operation.

The operator's guard is built integral with the frame, providing greater strength, additional safety to the operator and better appearance. The right side forms a handy compartment for carrying towing chain, pinch bar or other tools.

Included on the truck are such standard Baker features as the Baker travel motor, designed specifically for industrial truck service, the Baker duplex compensating suspension, which eliminates all sliding contacts between the power axle and frame, and the Baker no-plug controller, which provides three speeds in each direction, controlled by a single handle.



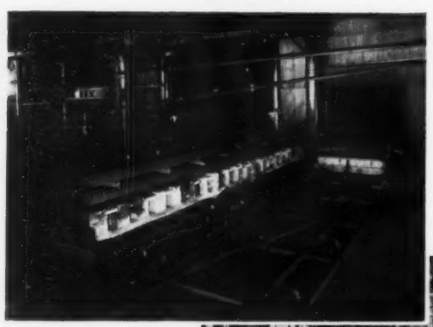
This new 6000 lb truck has the standard Baker features, as well as many recent improvements contributing to easy, economical operation.

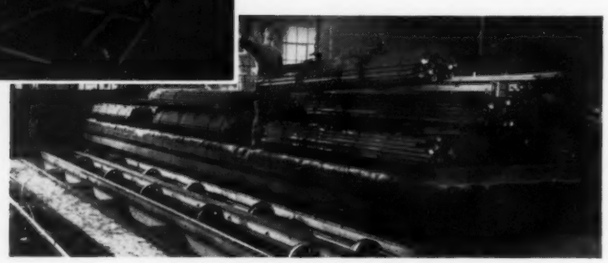
For complete specifications and dimensions ask for Bulletin 1211-a.

CONVEYOR FOR HEAT TREATING SMALL PARTS

▲ The Standard Alloy Company, Inc., Cleveland, Ohio, manufacturers of nickel and chrome heat and corrosion resisting alloys, have recently developed a conveyor belt made up of cast links that has proven very satisfactory in the heat treatment of various war materials, such as 30 and 50 caliber cartridge cases, small caliber shot, balls and rollers for bearings, wrenches, cartridge clips, bolts and nuts, light stampings and forgings, etc., where the load does not exceed 40 pounds per square foot of belt area. The multiple purposes of this belt are most apparent because it lends itself to the heat treatment of a large variety of peace-time products which industry will be considering the very moment our V-Day arrives. This belt is made up of cast links that interlock and then is fastened together with ¾ in. rolled alloy rods. This belt can be made up in widths from 12 to 60 in. by multiples of 2 in., but in most instances, where the belt exceeds 30 in. in width, the manufacturer recommends putting on two belts.

PHILLIPS Transfer Cars SPEED FURNACE PRODUCTION





Phillips Transfer Cars Meet Exacting Requirements

In these war-busy days—with heat-treating a *most* vital factor—Phillips Transfer Cars quickly move Furnace Cars from loading area to furnace to quench tank. Phillips Transfer Cars feature under-slung construction . . . Timken bearings . . . minimum pit depth . . . rope or motorized haul.

Get the PHILLIPS FACTS!

MANUFACTURERS SINCE 1863

PHILLIPS MINE AND MILL SUPPLY COMPANY

PITTSBURGH, PENNA.

MINE & INDUSTRIAL CARS—FABRICATED STEEL—IRON CASTINGS

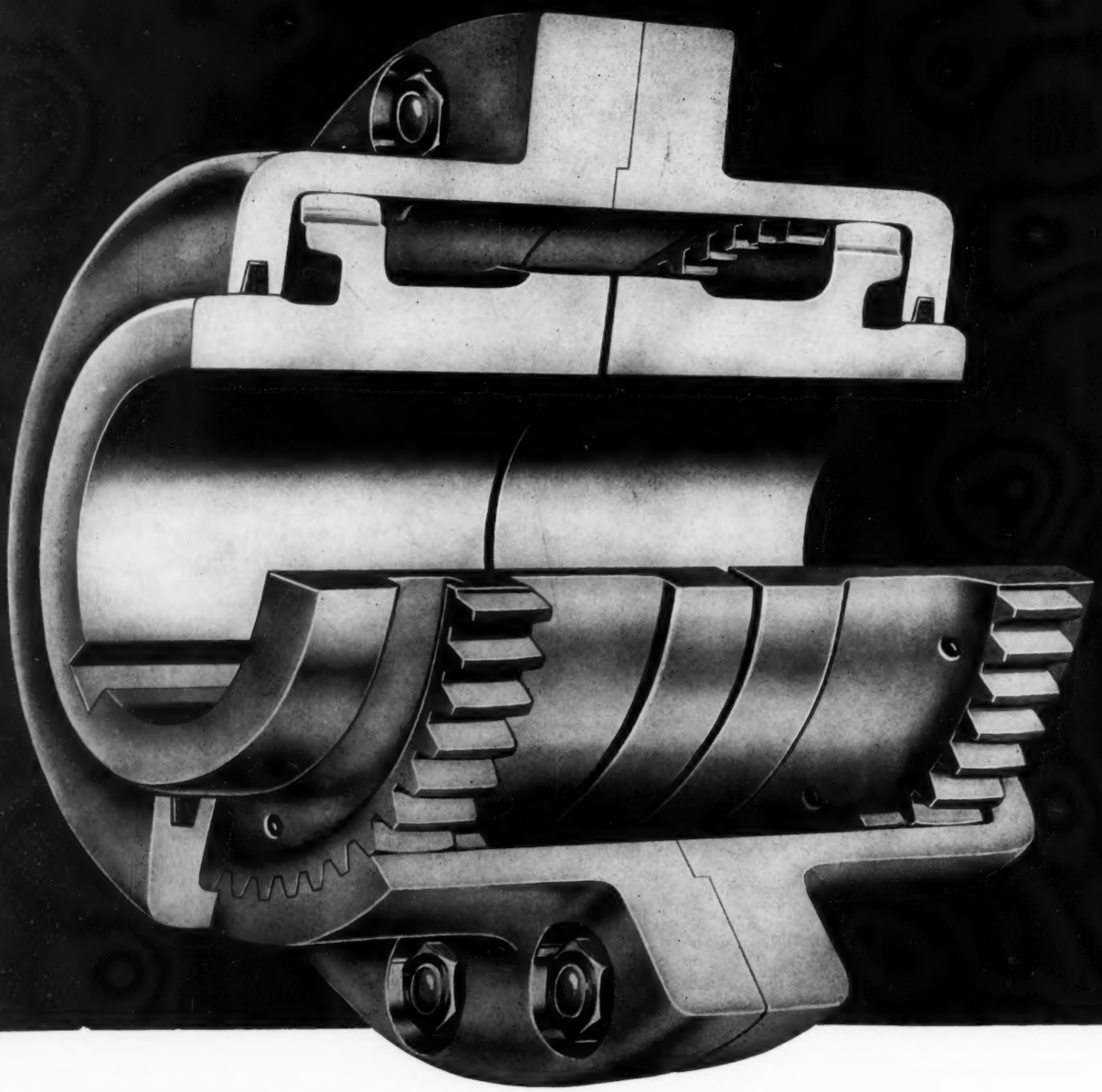
heft

for any materials handling job!

Regardless of the weight, size or type of load, Heppenstall Safe-T Tongs will replace chains, slings or hooks and handle the load faster, safer and more economically . . . Heppenstall tongs are fully automatic—not power driven—no close work by ground crews needed. They are all specially designed for each specific job and are solving new problems in materials handling every day. Write for our new booklet that tells the complete story—you may get an idea from it that will save your plant considerable time, trouble—and money...Dept. M , Heppenstall Company, Pittsburgh, Pa.

Heppenstall Automatic Safe-T-Tongs

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Each belt is 18 in. wide, and operating on the same drum makes a total width of 36 in. The teeth on the driving drums pull on every link, thereby making the pull across the belt uniform. The idler drums have rings cast around the barrel that ride in between the ribs on the bottom of the belt, holding it in line, thereby eliminating any danger of the belt running over against the sidewalls of the furnace.

The sidewalls on the belt can be made any height up to 3 in. high. Another very good feature is that ribs can be cast or the top of the individual links, either running lengthwise or crosswise of the belt, to eliminate round pieces from touching each other or keeping them from rolling around on the top part of the belt. The holes on the links where the hinging rods go in are elongated 1/8 in., so if the rods or crankshaft wear from long service, the pins can be driven out and new pins replaced. These belts in most cases operate entirely within the furnace proper, cutting the heat losses to a minimum. At the present time, The Standard Alloy Company, has in operation more than 150 of these belts operating on various types of war materials; in one plant alone, processing small caliber cartridge cases, 48 belts are now in operation.

CARNEGIE SETS 31 NEW RECORDS

▲ Men and women steelmakers of Carnegie-Illinois Steel Corporation continued their unprecedented production for war during October when they set 31 new monthly production records, including new marks for the South Chicago and Gary plants.

Included in the 31 new records of this U. S. Steel Corporation subsidiary was a world's peak for monthly output of steel ingots, otherwise, the production by Carnegie-Illinois Steel of 2,033,933 net tons of ingots and castings.

The South Chicago plant blast furnaces contributed a new record for monthly production of pig iron, together with furnaces at Clairton and Carrie furnaces of the Homestead plant in the Pittsburgh district, where new marks also were set.

Open hearth steelmaking crews at Gary, South Chicago, Farrell, Homestead and Duquesne made new production marks for their units. Open hearth furnace production records were shattered for both the Chicago and Pittsburgh districts last month.

Rolling mill units at Homestead Steel Works reported new monthly records for the 30 in. and 32 in. slabbing mills and the 100 in. mill.

TEN FOOT BEARINGS FOR ANTI-AIRCRAFT GUN

▲ Anti-friction bearings ten feet in diameter, made by the Bantam Bearings Division of The Torrington Company, present a unique and interesting contribution to the war effort. These huge 120 in. diameter races machined and ground to precision limits of .002 in. in diameter and .001 in. in parallelism, are for the 5 in./38 cal. twin anti-aircraft gun mount for the Navy. This includes one race which is 1 7/8 in. wide and 3/4 in. in cross-section, and another race 1 1/4 in. wide and 2 1/2 in. in cross-section.

These tolerances are all the more amazing when translated in the similar proportions for more normal size

FORECAST:

Some day, you'll look up to this device

BASIC

in modern mill practice

This is the patented, exclusive Kemp Industrial Carburetor, the machine that provides complete premixing of gas and air to provide new savings, new heat liberation, new flexibility and new control in almost every type of ferrous and non ferrous heat processing.

As the basic unit in Kemp heat treating the Industrial Carburetor supports gas immersion melting in modern tin stacks, provides fuel for inert gas and for recirculating radiators in annealing covers, for Kemp Radiatube Roll Heaters, may be set for exactly the desired flame characteristics whether reducing, oxidizing or for complete combustion . . . and save 15 to 40 percent in fuel.

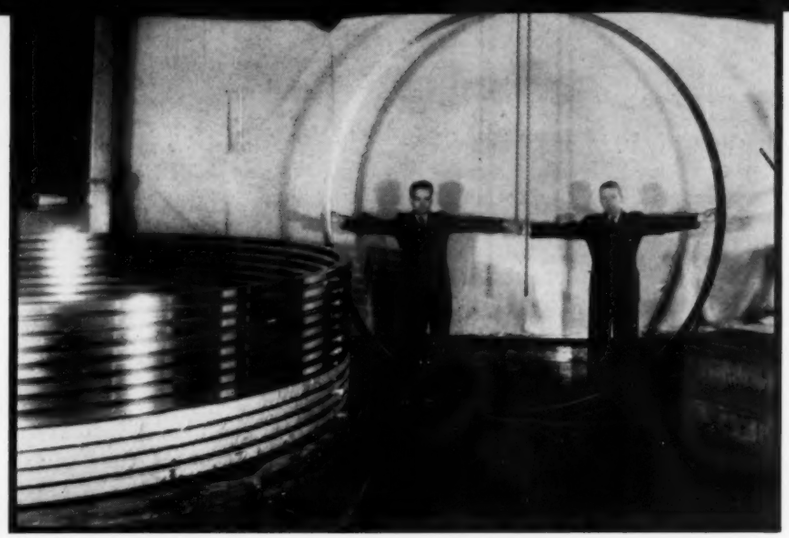
For engineering details and assistance, address **The C. M. Kemp Manufacturing Company, 405 East Oliver Street, Baltimore, Maryland**

The Army, Navy "E" Flag, awarded "for high achievement in the production of materials of war."

KEMP of BALTIMORE

bearings as they compare with a 12 in. diameter race .075 in. in cross-section held to a tolerance on diameter of .0002 in. and also to a race ⅛ in. wide held to a parallelism of .0001 in.

Races of this thin cross-section presented many problems, not only in manufacturing but also in inspection, because in measuring such large diameters, the usual micrometer gages were not satisfactory. For instance, a variation in temperature of 2 degees F between the gage and the race wouldresult in a variation of approximately .0016 in. and as mentioned, the total tolerance allowed is only .002 in.



Held to a tolerance of .002 in., this 10 ft diameter bearing race, of small cross-section, presents many production and inspection problems.

This involved special precautions to see that the temperature of the gage and races was the same and that interchangeability of all the parts was accomplished, so that in making replacements of these bearings due to battle damage, any of the races was interchangeable with those previously used. These races and rollers are then chrome plated to a thickness of .0003 to .0005 in. in line with U. S. Navy standards for gun mount bearings of this type.

Shipment ahead of schedule was an important factor in enabling gun mount fabricators to complete vital war contracts for these anti-aircraft guns months ahead of the anticipated dates.

SEAMLESS TUBING SPEEDS GUN PRODUCTION

▲ One of the most exciting developments of World War II, a method that enables a single production line to turn out more than 6,000 75 and 40 mm gun tubes a month, was revealed recently by officials of The Timken Roller Bearing Company, Canton, Ohio.

This almost incredible speed-up in the production of heavy gun tubes is possible through the use of seamless steel tubing and a Timken-developed process that is the closely guarded secret of a few men.

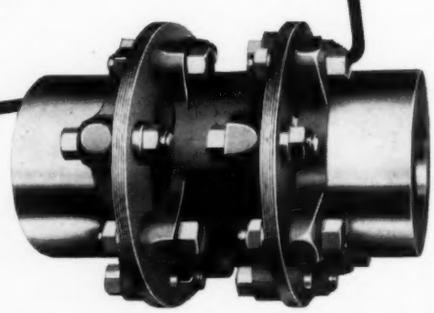
When the war broke in December, 1941, heavy guns for tanks, planes,

THOMAS
FLEXIBLE
COUPLINGS

5 exclusive features: save millions of dollars in maintenance every year and provide longer life for your equipment.

NO BACKLASH
NO WEAR
NO LUBRICATION
NO THRUST
FREE END THRUST

These are the five essential features for a permanent care-free installation not found in any other make or type of flexible coupling.



For specifications on couplings for all standard purposes write (on your letterhead) for the new Thomas Catalog with complete engineering data.

"BUILT TO LAST A LIFETIME"

THOMAS FLEXIBLE COUPLING CO.

WARREN, PENNSYLVANIA

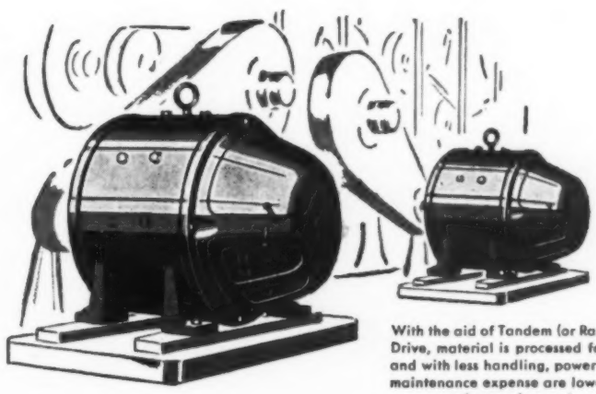
C-3

TANDEM!

Wherever possibilities exist for arranging machines to operate in tandem, or series, so as to keep material moving and cut out stopping places, Reliance engineers can offer constructive help.

Pioneering work done by Reliance in adapting motor-drives to the continuous processing of materials in coil form has done much to reduce costs and improve quality and uniformity.

If you would like to talk over the applications and requirements of tandem operation and ways in which motors can be teamed up to produce most satisfactory results, send for a Reliance man.



With the aid of Tandem (or Range) Drive, material is processed faster and with less handling, power and maintenance expense are lowered and space is saved

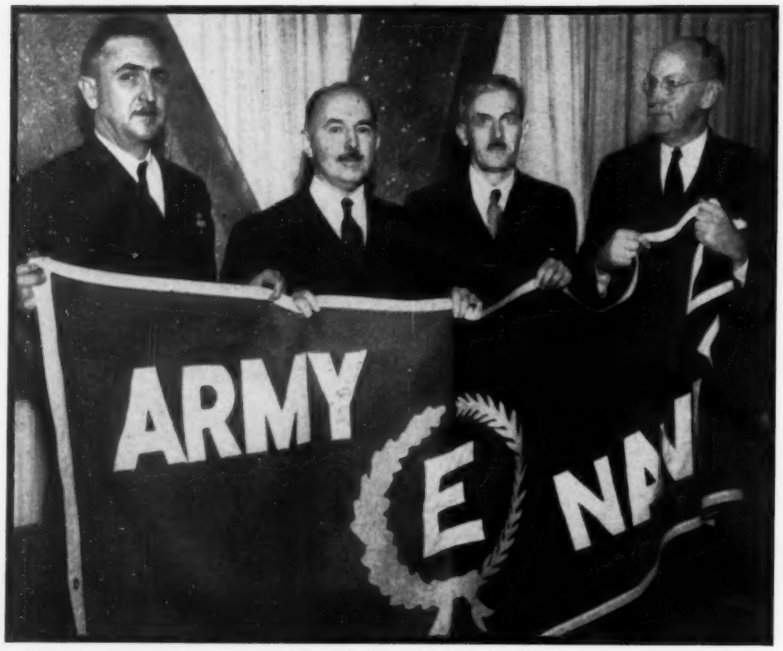
RELIANCE A·C D·C MOTORS

RELIANCE ELECTRIC & ENGINEERING CO.

1088 Ivanhoe Road • Cleveland, Ohio

Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S.C.) • Houston • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Portland (Ore.) • St. Louis • San Francisco (Calif.) • Syracuse (N. Y.) and other principal cities.

CLEVELAND FIRM CITED FOR WAR WORK



Employees of the Cleveland Worm and Gear Company and the Farval Corporation have been awarded the Army-Navy "E" for excellence in producing war materials. The flag was presented during impressive ceremonies by Commander Harry H. Keith of the U. S. N. Bureau of Ships, and lapel pins by Major Albert C. Crawford of the Fifth Service Command, Fort Hayes, Ohio. Holding the flag from left to right are Commander Keith; A. J. Jennings, vice-president in charge of sales; George H. Acker, vice-president in charge of engineering and production; and Howard Dingle, president.

and ships were sorely needed. Existing forging facilities could not hope to produce them fast enough. The then standard forging method of making gun tubes takes time — to rifle the bore, to machine, to remelt the abundant scrap it makes. Expanding forging facilities was out of the question; too many precious months would be lost.

Executives of The Timken Roller Bearing Company came forward with a long-cherished idea: heavy gun tubes made from seamless steel tubing, at almost incredible savings of time and material, using vast, immediately available facilities that eliminated the need of scarce forging equipment.

A few months later, on April 17, Lieutenant General Brehon B. Somervell stood up before an audience of 8,000 munitions workers in Harrison, New Jersey, and told them of the result. He said: "We have developed a new way of making heavy gun barrels. Within a few weeks, one single American factory using this new process will be turning out each month more heavy gun barrels than all the factories of England turned out in the whole war."

By upsetting the breech end from seamless steel tubing rolled to the diameter of the tube, rather than machining, casting or forging it from a steel bar cut to the diameter of the breech, much time and steel are saved. Piercing the gun tube is a matter of seconds, compared to the hours formerly required to form the bore.

Piercing white hot tube to form bore of new U. S. 75 mm gun tube, whose record-breaking production according to a closely guarded secret process developed by The Timken Roller Bearing Company, Canton, Ohio, has given our armed forces thousands of heavy gun tubes each month — a monthly rate greater than England's total wartime production. Operation shown above takes 15 seconds time, once took six hours using pre-war method of machining bore.

HOW DOES THE AMPLIDYNE WORK?

By FREMONT FELIX
General Electric Company
Schenectady, N. Y.

▲ The amplidyne, widely used in the steel industry as in most fields where electrical energy is utilized, is a two-stage dynamo-electric amplifier.

Both its amplification and its speed of response are so high that normally one would expect that they could be obtained only by the use of complicated equipment.

Yet this product of General Electric engineering is a machine of the same outward appearance and of the same physical dimensions as a conventional direct-current generator of the same output.

How can the amplidyne accomplish so much and yet be so simple? Its unique engineering principle is explained in the two accompanying illustrations:

In the conventional generator shown at left, excitation requirements are relatively high, say 100 watts to produce an output of 10,000 watts. Hard-working "excitation" is pumping energetically to produce the necessary magnetic field (excitation flux) and this takes all his attention. He is getting no help whatsoever from the strong but lazy armature reaction

ROCKBESTOS A.V.C.

Maintains Production Schedules with a Permanent Insulation

that Won't ROT or BAKE BRITTLE

Why Rockbestos Permanent Insulation Prevents Premature Wire Failure

Rockbestos A.V.C. Power Cable, illustrated*, 600 to 5000 volts, No. 18 A.W.G. to 1,000 MCM, Underwriters' and N.E. Code, Type AVA, maximum operating temperature 110°C., has this permanently insulated construction.

1. The conductor is permanently centered in helically applied insulation that will not flow, migrate, dry out, crack or rot.

2. Felted asbestos insulation withstands conductor-heating overloads and won't burn even when exposed to copper-melting arcs.

3. Lubricated varnished cambric for high-dielectric strength and added moisture resistance, protected from heat, flame and oxidation between two felted asbestos walls.

4. Felted asbestos insulation impregnated with heat, flame, and moisture-resisting compounds will not dry out, become brittle, or burn. Also serves as a heat-barrier against high ambient temperatures.

5. A tough, rugged impregnated asbestos braid, resistant to heat, flame, moisture, oil, grease and corrosive fumes.

**One of 122 different wires and cables developed for severe operating conditions by Rockbestos.*

RESISTS moisture, oil, grease and fumes. WON'T bake brittle, burn, flow or rot.

Baking, withering heat causes more failures in circuits running around furnaces, lehrs, kilns, steel mills, power plants, steam tunnels, etc., than any other trouble maker. It dries out the insulation, opens cracks to moisture, sets up shorts, rewiring jobs, equipment and production outage—unless the wire is *permanently insulated* like Rockbestos A.V.C. This construction with its laminated asbestos and varnished cambric insulation, covered with a tough asbestos braid, won't bake brittle, crack, swell, flow or rot under heat and is also resistant to moisture, oil, grease, corrosive fumes and flame. Other Rockbestos wires, cables and cords designed for severe operating conditions are available in our line of 122 standard constructions. For information or recommendations write to nearest branch or:

Rockbestos Products Corp., 917 Nicoll St., New Haven 4, Conn.

For Victory—Invest in U. S. War Bonds

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE

ENGINEERS AND MAINTENANCE MEN

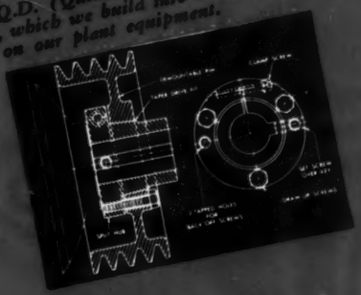
ELECT

QD QUICK DETACHABLE

SHEAVE

TO SOLVE THEIR DRIVE PROBLEMS

CHIEF ENGINEER *We have standardized on the Q.D. (Quick Detachable) Sheave Design, which we build into our products and use on our plant equipment.*



BALANCED DESIGN

- ✓ Overhang stresses reduced 25%.
- ✓ All weave and wobble eliminated.
- ✓ Reduction of bearing loads and shift stresses on short stub—shaft applications.

MAINTENANCE ENGINEER *Seasonal speed changes are easy now—don't have to worry about alignment, scored shafts, burned bearings, or cracked sheaves, when we change Q.D. Sheaves.*

ALWAYS TIGHT ON THE SHAFT

- ✓ The equivalent of a press fit.
- ✓ Perfect fit on undersize or oversize shafts.
- ✓ Capacity to handle any shock loads.

MAINTENANCE FOREMAN *The Q.D. Sheave is so easy to get on or off that the women in our shop do the job in short order with only a wrench.*

EASY TO GET ON EASY TO GET OFF

- ✓ On or off with only a wrench in sixty seconds.
- ✓ Seasonal speed changes made faster, safer, easier, cheaper.
- ✓ Alignment always maintained...hub element remains intact on shaft.

One demonstration of the Q.D. (Quick Detachable) Sheave principle will convince you of its superior operating and maintenance advantages. For your demonstration write the nearest district office or call the Authorized Worthington Multi-V-Drive Dealer in your territory today. He is prepared to serve your transmission needs with a complete range of Q.D. Sheave sizes that will accommodate 10,000 drive combinations up to 150 horsepower, available from stock.

For more information write to the Standard Products Division for your copy of the New Q.D. Sheave Bulletin V-1400 B7C.

WORTHINGTON MULTI-V-DRIVES

COMPLETE DRIVES • SHEAVES OR BELTS ONLY

WORTHINGTON PUMP & MACHINERY CORPORATION

GENERAL OFFICES: HARRISON, N. J.

MULTIPLE V-BELT DRIVE ASS'N

In America's Steel Centers

HARVEY KING
BIRMINGHAM, ALA.

THOMAS E. BEASLEY
CHICAGO

In American Steel Centers you'll find The Clark Controller Company offices, each staffed by "3C" Application Engineers, many of whom have "grown up" in the Steel Industry.

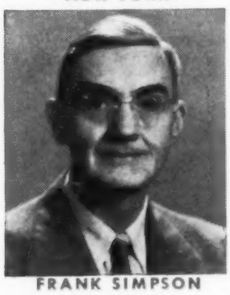
These veterans have unstintingly given of their knowledge and experience to their younger colleagues so that each "3C" office has practical "know how" engineers at your command.

Backing up these field men are the "3C" Home Office Engineers – with broad experience in Steel Mill Electrical Control problems—all for better service to users of "3C" Heavy Duty Electrical Control apparatus.

You'll find the picture of the "3C" Application Engineer whose office is nearest you, on this page. Get in touch with him—he's there to be of service to you.

ROBERT H. HOGE
NEW YORK

LESTER H. COLBERT
CLEVELAND


FRANK SIMPSON
CINCINNATI

EDWIN R. JUNG
NEW YORK

GORDON W. FIRST
PITTSBURGH, PA.

RICHARD V. ANDERSON
DETROIT

DON L. ORTON
GARY, IND.

O. L. HOLCOMBE
PHILADELPHIA

J. L. VAN NORT
SALT LAKE CITY

HARRY J. FISHER
CLEVELAND

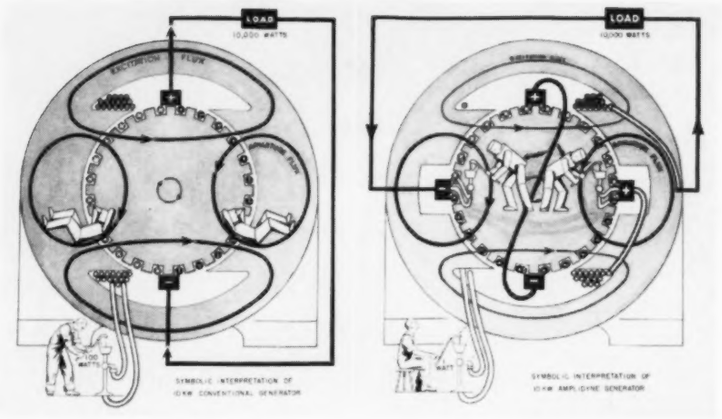
CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, 10, OHIO

"robots" created by the armature current, but doing no useful work.

In the figure at the right, the conventional generator has been transformed into an amplidyne. This has been accomplished by short-circuiting the original brushes, and adding two new load brushes and a compensating winding. Excitation requirements have been cut to 1 watt from 100, and it is no work at all for "excitation" to supply this minute amount and keep his eye on the load at the same time. Yet the same output as before — 10,000 watts — is obtained from the machine, because the armature reaction "robots," their lazy days over, are now at work, prodded by the short-circuit current, following very faithfully and promptly every command of their boss, and producing armature voltage where it is collected by the new load brushes.



The conventional generator (left) is transformed into an amplidyne (right) by short-circuiting the original brushes and adding two new load brushes and a compensating winding.

Any changes in "excitation" are promptly reflected in the short-circuit current (first stage of amplification) and the short-circuit armature reaction in turn determines the final output at the load brushes (second stage of amplification).

A full stage of amplification has been added where "armature reaction" was idle before. No wonder that the amplidyne is performing miracles!

BETTER PRODUCT CONTROL is possible with Hays Draft or Pressure Recorders which are a positive guide to balanced draft conditions in soaking pits, open hearths, slab mills, annealing and other furnaces. They eliminate guesswork, save man power and reduce rejects to the minimum. They are a real help in the all-out effort for bigger and better steel production.

The ten-inch, 24 hour charts give a permanent record of day in and day out performance of every furnace. Two draft values, two pressure values, two differential values or any combination of two of these three values may be recorded. Or temperature may be included if desired and mercury switches may be provided to operate an alarm or a power unit to open and close a damper, etc.

Any way you look at it, the Hays Series OT Draft Recorder is a Guard over furnace operation and merits your investigation. ***Write for Bulletin 39-232.***

The HAYS CORPORATION
SINCE 1901
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A

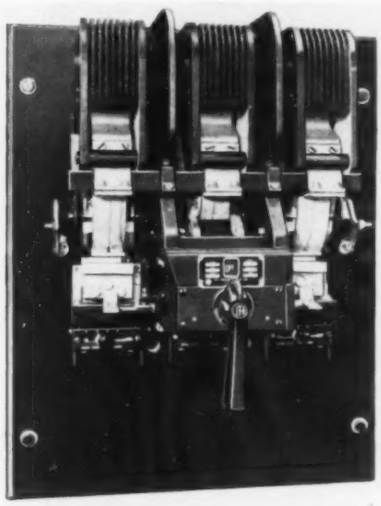
TRIP-FREE AIR CIRCUIT BREAKER ANNOUNCED

▲ A new trip-free air circuit breaker, known as Type KC, with an interrupting rating of 50,000 rms amperes, is offered by the I-T-E Circuit Breaker Company, Philadelphia, Pennsylvania. Ratings are 600 volts a-c, 250 volts d-c, 100 to 1600 amperes. Operation may be either manual or electric; one, two, and three pole styles are offered. Mounting may be on open type (live-front) or dead-front switchboards or in individual steel enclosures of general purpose or weatherproof construction.

Construction features include silver-alloy main contacts brazed to solid copper blocks, auxiliary and arcing contacts which are also made

of silver-alloy and magnetic arc chutes with blowout coils and iron vanes. Manual operation makes use of a large, pistol-grip handle which requires turning only ninety degrees to open or close the breaker. Electrically operated breakers are provided with a unit-type solenoid mechanism and a trip-free closing relay.

The photograph shows a manually operated type KC circuit breaker. A complete description is given in Bulletin 1301, which may be obtained from the I-T-E Circuit Breaker Company.



ARMY-NAVY "E" FOR EXCELLENT PERFORMANCE

H. A. Brassert, chairman of the board of directors of the Askania Regulator Company, presided as master of ceremonies at the Army-Navy "E" presentation held on October 26th, 1943 at the 16th Street Armory, Chicago, Illinois.

The Army-Navy "E" award has been given to the Askania Regulator Company for the excellence of their performance in supplying automatic control equipment for war plants and special devices for the Navy.

Lt. Comdr. James L. Wisenbaker, U. S. N. presented the "E" pennant to the workers of the Askania Regulator Company and Major J. R. Weber made the presentation of the "E" pins.

H. J. Velten, president of the Askania Regulator Company accepted the Army-Navy "E" award flag at the presentation.

Holding the pennant, reading left to right are Major Weber, Mr. Velten, Mr. Brassert and Lt. Comdr. Wisenbaker. At the extreme right is Mr. H. P. Niemann, vice-president Askania Regulator Company.

BLOOMING MILLS FOR SMALL STEEL PLANTS

▲ Through a marked advance in blooming mill design, Birdsboro's new 2-high rapid-reversing 26 in. blooming mill makes possible an exceptional speed increase in ingot blooming production. Rolls 32 tons per hour — a saving of 33⅓ per cent in man hours per ton over the most productive conventional 3-high hand mill.

Besides rapid-reversing features, this Birdsboro rolling mill provides fast screw-down, and rapid manipulation. It is used for blooming ingots of mild, tool, non-corrosive, automotive, aircraft and special purpose steel and produces slabs from 1½ x 6 in. to 16 in. wide, or 100 sq in., maximum thickness 9 in.

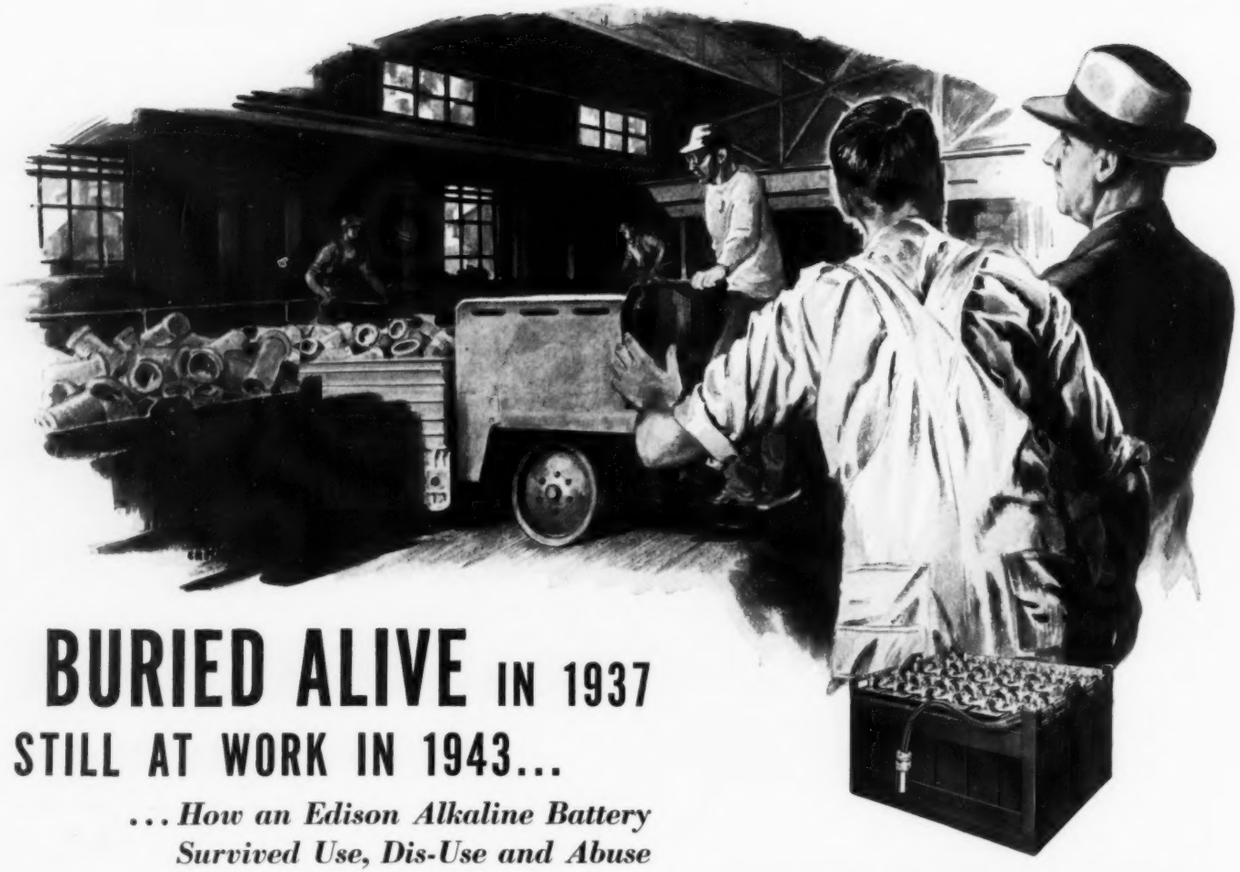
Each mill is powered by a main drive reversing 1750 hp motor. Two 50 hp motors located over the top housing operate the roll lift.

Ingots are taken from the soaking pits by overhead traveling cranes which place them in an electric tilter for feeding directly onto the mill tables. In the illustration a hot ingot has left the tilter, and is being quickly reduced to size as it speeds back and forth through the forming rolls. In an overhead control room, two operators pilot the ingot: the roller handles all controls for percentage of reduction or screw-down on each pass, reversing table rolls and motor reverse; the other operator controls the side guards or pass guide and ingot manipulator.

Birdsboro 26 in. mills are inexpensive to install, and their low maintenance cost and low power consumption cost are particularly beneficial in small steel plant operation.

New Literature

▲ A 64-page pocket-sized booklet, "Useful Tables of Weights and Measures," has just been published by



BURIED ALIVE IN 1937
STILL AT WORK IN 1943...

... How an Edison Alkaline Battery Survived Use, Dis-Use and Abuse

In 1937, a midwestern foundry changed hands after being shut down six months. The electrician of the new owners, in the course of putting the industrial trucks into operation, found one of the batteries buried under a mound of earth beside an open trench.

He knew it must have been there at least six months and, although it was an Edison Alkaline Battery, he was naturally doubtful whether it was still serviceable. Nevertheless, he ordered it cleaned, painted and charged. Much to his surprise, it performed satisfactorily in every way when put into one of the trucks. Now, six years later, the electrician tells an Edison engineer that the same battery is still in regular service.

Edison Alkaline Batteries are meant to stand use—long use and hard use, in mines, railroads and industry. They can also stand disuse, indefinitely, if discharged, short-circuited and properly stored. But the fact that they can, and often do, survive outright abuse is striking evidence of their great reserve of dependability under all conditions.

Some of the unique characteristics which enable the Edison Alkaline Battery to stand up under use, disuse and abuse are cited in the column at the right.

ADVANTAGES OF THE EDISON ALKALINE BATTERY FOR USERS OF INDUSTRIAL TRUCKS

★ It is durable mechanically. High strength steel construction is used in the container, grids, pole pieces, etc. The electrolyte is a preservative of steel. It requires no renewal of separators throughout its long life.

★ It is foolproof electrically. It may be short-circuited, over-charged, over-discharged, or even accidentally charged in the reverse direction without injury.

★ It can be charged rapidly. It may be charged at full normal rate throughout the entire length of charge and is not subject to finish rate limitations. It requires no equalizing.

★ It withstands temperature extremes. It is not damaged by freezing. Free air spaces on all sides of all cells provide ventilation for rapid cooling under high temperature conditions.

★ It is free from ordinary battery troubles. It is not subject to sulphation, shedding of active material, buckling of plates, jar breakage or other common causes of battery failure.

★ It is simple to maintain. Merely charge adequately, add pure water, keep clean and dry.

★ Its tray assembly and cell connections are extremely simple.

★ Its life is so long that its annual depreciation cost is less than that of any other type of storage battery.

EDISON STORAGE BATTERY DIVISION, THOMAS A. EDISON, INCORPORATED, WEST ORANGE, NEW JERSEY

Edison

ALKALINE BATTERIES

HEAVY ARTILLERY FOR THE WAR PRODUCTION FRONT

READY ...TO SERVE YOUR NEEDS FOR NORDSTROM VALVES

We have made tremendous progress on our backlog of orders and within a few weeks, if not by the time this message appears, we will be largely in the clear on critical steel valves. We will then have open capacity to handle new steel valve business in the sequence received, subject, of course, to the priority rating assigned.

NEED VALVES AT ONCE? Right now we have available manufacturing facilities that are not suited to the production of steel valves and we can effect immediate stock delivery of Nordstrom Semi-Steel Valves in certain sizes and figure numbers.

AIM ...YOUR SIGHTS NOW ON LATE 1943 AND FIRST QUARTER 1944 CONSTRUCTION

Those booking orders now, in anticipation of late 1943 and early 1944 valve requirements will have first call on our facilities. Immediate action on your part is desirable so that we may establish firm delivery dates based upon amply foreseen needs for materials and carefully predicated manufacturing schedules.

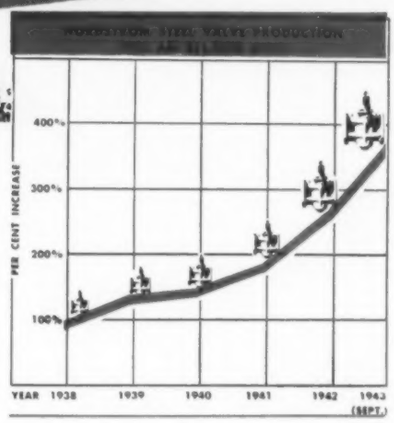
FIRE ...YOUR INQUIRIES AND ORDERS AT US

We can handle your immediate business in many lines and orders for Nordstrom Valves of any type can be accepted with excellent prospect of delivery within a maximum of ninety days after receipt of firm specifications. The WPB lead factor for cast steel valves is 90 days.

Merco Nordstrom Valve Company, in common with the entire valve industry, is emerging from a very trying period. Earlier this year the need for valves in vital wartime industries greatly exceeded all available facilities. Nordstrom was ordered to produce 600% over normal capacity during a short period and then was confronted with shortages ranging from man-power and machine tools through storage facilities and materials. These handicaps, we are pleased to report, have now been largely eliminated—thanks to a realization on the part of the War Production Board of the indispensable and unique position occupied by Nordstrom Valves.

Our tonnage of cast steel Nordstrom Valves has shown a progressive increase month by month. Our plant capacity is now geared to a production rate never before attained in our history. We know of no other valve company that has had a greater load thrust upon it or has used more vigorous efforts to satisfy the demands of their customers.

Out of all this has come a stronger more integral Nordstrom organization —one capable of handling the immediate needs of today and with adequate post-war facilities to service an increasing circle of Nordstrom Valve users.



MERCO NORDSTROM VALVE COMPANY

A Subsidiary of
Pittsburgh Equitable Meter Co.

Main Office: Pittsburgh, Pennsylvania

Branches: Boston • Buffalo • Brooklyn • Chicago Columbia, S. C. • Houston • Kansas City • Los Angeles • Memphis • New York • Oakland Seattle • Tulsa • San Francisco

NORDSTROM VALVES KEEP UPKEEP DOWN

Mesta Machine Company. Included are tables of sheet and tinplate gage, weights of square and round steel bars, relative sizes of ingots and forgings at various reductions, properties of metals, flow of water through pipes, SAE steels, and a number of conversion tables. Copies of this booklet may be secured upon request to Mesta Machine Company, P. O. Box 1466, Pittsburgh (30), Pennsylvania.

▲ "National Fire Codes for Flammable Liquids, Gases, Chemicals and Explosives, 1943," recently published by the National Fire Protection Association, appears at a most propitious time as an authoritative guide for preventing fires incident to the handling, storage and use of flammable liquids, gases, chemicals and explosives. It brings together the many standards dealing with these hazards, and supersedes the National Fire Codes for Flammable Liquids and Gases, Edition of 1938.

This new volume is divided into 9 parts as follows: Flammable Liquid Storage and Handling; Oil and Gasoline Burning Equipment; Liquified Petroleum Gases; Utilization of Flammable Liquids; Gases; Refrigeration and Fumigation; Explosive and Nitrocellulose Materials; Tables of Properties — Hazardous Chemicals, Flammable Liquids; Flash Point Tests.

The several codes are in the form of suggested ordinances, standards or recommended good practice requirements. They are universally recognized and used as the authoritative guides to the best practice. Irrespective of their form, the codes are purely advisory as far as the N. F. P. A. is concerned. They are, however, widely used as a basis of law, or by administrative authorities in the exercise of their discretionary power, as well as by property owners as a guide to good practice, and for insurance purposes. In preparing all standards the aim of the N. F. P. A. committees has been to specify measures that will provide reasonable fire safety without prohibitive expense, or undue inconvenience.

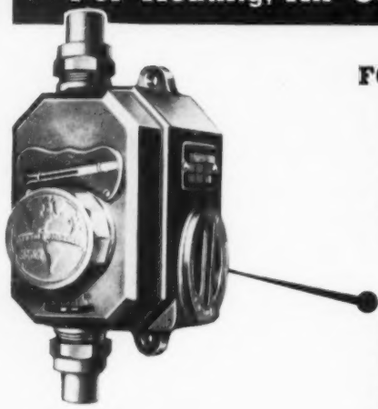
This 504 page book contains many tables and drawings. Page size 6 x 9 bound in substantial red cloth covers. Price $3.00 per copy postpaid. National Fire Protection Association, 60 Batterymarch Street, Boston 10, Massachusetts.

▲ An unusual combination of catalog and engineering manual has been prepared for early distribution by the Victaulic Company of America.

The new Victaulic handbook is a comprehensive listing of flexible couplings and fittings for use with grooved pipe, as well as a guide to their use in industrial, mining, petroleum, shipbuilding, and water works and sewerage fields. The engineering and catalog material have been tabulated by industries to facilitate its quick and easy use.

In announcing this catalog-manual, the company states that its activities at the present time are for the most part necessarily secret. It was recently revealed, however, with the permission of the War Department, that Victaulic couplings played an important part in laying temporary military pipelines in North Africa and Sicily. These Victaulic-coupled pipelines were the answer to the problem of keeping fast moving front lines supplied with vital fuel for planes and other mechanized equipment. They solved a serious transportation problem in a blitz war by making it possible to lay pipe at the rate of 10 to 30 miles a day.

CROUSE-HINDS
Thermostat Condulets
For Heating, Air Conditioning, Refrigeration



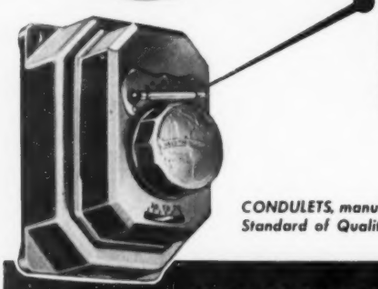
FOR HAZARDOUS LOCATIONS

Explosion-Proof and Dust-Tight— Suitable for use in atmospheres containing ethyl ether vapor; gasoline, naptha, petroleum, benzol, alcohols, acetone, lacquer solvent vapors and natural gas; metal dust; carbon black, coal or coke dust; grain dust; combustible fibers.

Type HRC
Mercury tube switch.
Threaded flame-tight cover.
Through feed ½-inch union hubs. Either hub can be capped.
Accurate thermometer for indicating room temperature.
Locking arrangement can be furnished to prevent regulating by unauthorized persons.
Listed in Condulet Catalog No. 2500. Section 85. Page 50.3.

Type HR
Contactor snap switch.
Ground surface flame-tight cover.
Reversible. ¾-inch hub can be at top, bottom, or either side.
Accurate thermometer for indicating room temperature.
Regulating knob removable to prevent unauthorized regulating.
Listed in Condulet Catalog No. 2500. Section 85. Page 50.4

FOR NON-HAZARDOUS LOCATIONS



Type FHRC
Mercury tube switch.
Through feed ¾-inch hubs flush with top and bottom of body. Removable plug for either hub.
Accurate thermometer for indicating room temperature.
Locking arrangement can be furnished so thermostat can only be regulated by authorized persons.
Listed in Condulet Catalog No. 2500. Section 50. Page 228.

CONDULETS, manufactured only by CROUSE-HINDS are the Standard of Quality in the field of electrical conduit fittings.

A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY
SYRACUSE, N. Y., U.S.A.

Offices: Birmingham – Boston – Chicago – Cincinnati – Cleveland – Dallas – Denver – Detroit – Houston – Indianapolis – Kansas City – Los Angeles – Milwaukee – Minneapolis – New York – Philadelphia – Pittsburgh – San Francisco – Seattle – St. Louis – Washington
Resident Product Engineers: Albany – Atlanta – Charlotte – New Orleans
CROUSE HINDS COMPANY OF CANADA, LTD. *Main Office and Plant:* TORONTO, ONT.

GALVANIZERS DISCUSS POST-WAR PROBLEMS

The thirteenth meeting of the Galvanizers Committee sponsored by the American Zinc Institute, was held at the William Penn Hotel, Pittsburgh, Pennsylvania, November 17, 18. Pictured at the committee's dinner, from left to right, seated: N. E. Cook, Wheeling Steel Corporation; R. J. Greenly, Carnegie-Illinois Steel Corporation, guest speaker at the dinner; D. A. Russell, Youngstown Sheet and Tube Company; and F. G. White, Granite City Steel Company; standing: G. Brayton, Newport Rolling Mills Company; W. R. Shimer, Bethlehem Steel Company; C. K. Lytle, Tennessee Coal, Iron and Railroad Company; Robert Stoker, Carnegie-Illinois Steel Corporation; and E. V. Gent, secretary-treasurer of the Zinc Institute.

▲ George P. Reintjes Company, heat enclosure manufacturers, has developed a simple and effective sectionally-supported wall for the upper side wall areas of bent-tube boilers. This construction, proven in actual operation, is being used widely.

It eliminates the objectionable features inherent in the conventional solid masonry often used for the side wall areas above the drum supporting girders. It permits freedom of expansion of the drums while maintaining a tight air seal around the drum ends, and is universally applicable on bent tube boilers, either in existing or contemplated installations.

The construction is illustrated in Bulletin No. 431 recently issued by the Reintjes Company.

▲ The Brown Fintube Company, Elyria, Ohio, has just released a six-page, 2-color Bulletin, No. 432, describing their newly improved type BFT-1 "sectional hairpin" heat exchangers. This bulletin describes the "non-removable" rear end assembly introduced in these new exchangers, which is said to permit easy and quick entrance into the exchanger for inspection, cleaning, etc., also the easily assembled "head seal" — gives dimensions of standard sizes, performance data, and a detailed explanation of other design and structural features of interest to engineers, works managers, superintendents, etc. Copies available on request.

▲ Exidust central vacuum cleaning systems for industrial plants and buildings of all types are described in a new bulletin which has just been prepared by Allen Billmyre Company. The bulletin concisely outlines the benefits of this type of cleaning system, explains the special features and details of Exidust equipment, and the illustrations include sectional views and typical installation layouts. Copies of the bulletin can be obtained by writing to Allen Billmyre Company, 431 Fayette Avenue, Mamaroneck, New York and asking for Bulletin D4.

▲ Carbozite protective coatings — twenty-four well-illustrated pages, present the Carbozite Company's complete line of industrial coatings, prevention of industrial corrosion, product analysis, application charts and specific examples, with a most informative text. This is a very timely and helpful industrial catalog.

Available upon request to the Carbozite Corporation, 1010 First National Bank Building, Pittsburgh (22), Pennsylvania.

Air PRE-HEATERS
FOR ANNEALING FURNACES
Another, in the series of well built Tate-Jones furnaces. Let us know your requirements, we will gladly quote you on any size or type of furnaces.

TATE-JONES
& CO. INC. · LEETSDALE (Pittsburgh District) PA.

Rotating Hearth, Car Bottom, Pusher, Conveyor, Roll Down, Horizontal and Vertical Pit, Circular and Rectangular Pot Furnaces. Also Gas, Oil and Combination Burners

ITEMS OF INTEREST

J. J. Booth has been appointed superintendent of the maintenance department, Duquesne Works, Carnegie-Illinois Steel Corporation, succeeding the late T. E. Hughes. Mr. Booth was graduated from the University of Missouri in 1910 with the degree of B.S. in electrical engineering. During the summer of 1910 he located with the Missouri and Kansas Bell Telephone Company at Kansas City, Missouri. In January, 1911, Mr. Booth started work with the Westinghouse Electric and Manufacturing Company, East Pittsburgh Works.

In 1913 he took up work with the Carnegie Steel Company, Edgar Thomson Works, electrical engineering department, and remained with the Carnegie Steel Company until March, 1924, at which time he transferred to National Tube Company, Gary Works, as assistant superintendent of the electrical department and was made superintendent of this department in November, 1929. He has spent 30 years with subsidiary companies of the United States Steel Corporation.

Mr. Booth was president of the Association of Iron and Steel Engineers in 1931-32.

J. H. McElhinney was elected vice president in charge of operations, Wheeling Steel Corporation, succeeding Henry D. Scott who resigned. Mr. Scott will continue to be associated with the management of the corporation of which he is a director.

Mr. McElhinney first joined the Wheeling Steel Corporation seven years ago as assistant to the first vice president. Previous to that he had been with the Lukens Steel Company for over seventeen years, his last position with that company being general superintendent of the Coatesville plant. Prior to joining Lukens, Mr. McElhinney, who was graduated from the University of Pittsburgh in 1909, was engaged in power house construction for two years; in 1911 entered the employ of the United Engineering and Foundry Company, two years later joined the Youngstown Sheet and Tube Company; after service in World War I was identified with the Columbia Steel Company, acted as consulting engineer in the practice of Lief Lee, rejoined United Engineering and Foundry Company, and in 1926 went with Lukens.

E. N. Calhoun has been elected president of the Edwin L. Wiegand Company. Edwin L. Wiegand, who founded the company twenty-eight years ago, becomes chairman of the board. A. P. Wiegand was elected senior vice president in charge of manufacturing.

Mr. Calhoun joined the company in 1922 as a salesman and has held the offices of treasurer and general sales manager. The Edwin L. Wiegand Company is the largest exclusive manufacturer of electric heating units and equipment in the country and maintains engineering representatives in twenty-five principal cities throughout the United States.

Reginald E. Sturdy, former assistant superintendent of the Fairfield sheet mill of the Tennessee Coal, Iron and Railroad Company, subsidiary of the United States Steel Corporation, has been made superintendent of the mill.

A graduate of Purdue in 1914, Mr. Sturdy has been widely identified with the steel business since that time. In 1919 he began service with the American Sheet and Tin Plate Company. In 1936 he became superintendent of the Carnegie-Illinois Steel Company's New Castle Works. In 1938 he was transferred to Birmingham as assistant superintendent of the Fairfield sheet mill.

Joseph Kinney, Jr. has resigned as manager of the clad steel sales for Follansbee Steel Corporation. Before going with Follansbee, Mr. Kinney had handled industrial engineering work in New York City.

Previous to that he had been in Europe as general manager of United International, an affiliated company of United Engineering and Foundry Company and American Rolling Mill Company. Prior to this association, he had been assistant manager of machinery sales of the United Engineering and Foundry Company.

V. S. Acton has been appointed as manager, metal working section, Chicago office, according to an announcement by R. L. Irvin, Northwestern industrial manager of the Westinghouse Electric and Manufacturing Company. Mr. Acton succeeds J. R. Hauser who

J. H. McELHINNEY

E. N. CALHOUN

J. J. BOOTH

BUILT BY MORGAN *Engineering*

ROLLING ALUMINUM FOR WAR

● Among the many types of mill equipment built by Morgan, is the above mill consisting of two 22″ and two 18″ 3-high stands driven by one 22″ 3-high and one 18″ 3-high pinion stand, for rolling aluminum shapes. With this installation was furnished three oil hydraulic cropping and cutting-off shears to handle up to 5″ x 5″ aluminum billets. On such equipment for maximum production, the rugged stability of Morgan Engineering is well established, long since proved by the largest producers.

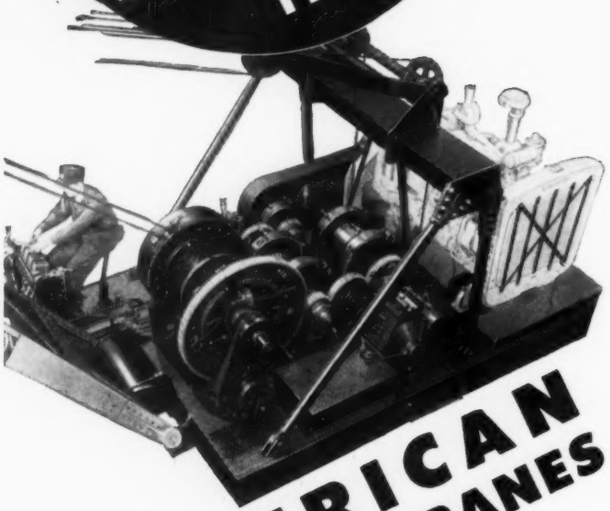
DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS
ELECTRIC TRAVELING CRANES • CHARGING MACHINES
INGOT STRIPPING MACHINES • SOAKING PIT CRANES
ELECTRIC WELDED FABRICATION • LADLE CRANES
STEAM HAMMERS • STEAM HYDRAULIC FORGING
PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO., Alliance, Ohio
Pittsburgh, 1420 Oliver Building

THE MORGAN ENGINEERING CO.
ALLIANCE, OHIO Pittsburgh, 1420 Oliver Bldg.

THIS DECK LAYOUT Saves MAINTENANCE TIME.....



on AMERICAN LOCOMOTIVE CRANES

The deck machinery is spread out to make all parts easy to get at. No pyramiding of parts. Mast does not have to be taken down to get at machinery on the deck.

Air tanks, control valves and pipes are at front of the machinery deck between the boom seats—NOT over the deck machinery.

These superior features of design save maintenance time.

Catalog No. 600-L-1A "tells all" *write for your copy*

60 Years of Safety 1883 - 1943 The Genuine CROSBY CLIP

AMERICAN HOIST & DERRICK CO
SAINT PAUL 1, MINNESOTA
Chicago San Francisco New York

AMERICAN TERRY DERRICK CO. . . . South Kearny, N. J.

has been appointed manager of the Minneapolis branch.

Graduating from the University of Nebraska, 1922, in electrical engineering, Mr. Acton joined Westinghouse the same summer and was immediately selected for the graduate training course offered by the company at their East Pittsburgh Works. In 1924, after serving

V. S. ACTON

in the East Pittsburgh sales department, he was appointed company representative for the Gary, Indiana office where he specialized in electrical applications for the iron and steel industry.

In 1938 he transferred his activities to the Chicago office as a member of the metal working section which he now heads.

J. H. Van Campen is now vice president of Loftus Engineering Corporation, Pittsburgh, Pennsylvania. Mr. Van Campen, a graduate of Pratt Institute, had previously been associated with the H. A. Brassert and Company, and also had served as chief engineer of the Corrigan-McKinney Division of Republic Steel Corporation. Mr. Van Campen's steel mill career began as a structural iron worker. In 1911 he joined the Bethlehem Steel Company as engineer of its Saucon plant, where he remained for six years. From there he went to the Weirton Steel Company, Weirton, West Virginia, as chief draftsman. He became assistant chief engineer

LOFTUS ENGINEERING corporation

1620 OLIVER BUILDING PITTSBURGH, PA.
BRANCH OFFICE
519 HOLLINGSWORTH BLDG. LOS ANGELES, CAL.

Engineers — Consultants — Contractors
Designers and Builders
of
MELTING • HEATING AND
INDUSTRIAL FURNACES

of the Midvale Steel Company, Coatesville, Pennsylvania, in 1920, and after remaining there for five years became special development engineer for the Timken Roller Bearing Company, working particularly on large bearings for mills. Subsequently he became chief engineer of the E. W. Bliss Company at Salem, Ohio, where he remained two years. This was followed by four years

J. H. VAN CAMPEN

as chief engineer for the Youngstown and Warren districts of the Republic Steel Corporation, which he left to spend a year in Japan doing special work for the United Engineering and Foundry Company.

John C. Graf has been appointed as sales manager of the hydraulic press and special equipment department of Baldwin Southwork Division, The Baldwin Locomotive Works.

Mr. Graf entered the employ of the Southwark Foundry and Machine Company, now the Baldwin Southwark division, in 1915, serving as draftsman, expeditor, inspector, purchasing agent and salesman. In 1925 he was made New England sales manager, holding that position until his new appointment.

Following his graduation from Temple University, Mr. Graf was employed for two years by the Link Belt Company. He then joined the Camden Iron Works of R. D. Wood and Company. His work with that firm included the design of hydraulic machinery and gas producers, and the installation and testing of gas producing plants.

WANTED - -

Libert High Speed Shear
No. 1036 or No. 1060
Give description and price.

E. D. RICHARDSON & SONS MFG. CO.
CAWKER CITY, KANSAS

ASKANIA
Predominant in
REPETITIVE UNIFORMITY *in* AUTOMATIC CONTROL

The problem of establishing the proper furnace pressure and combustion conditions necessary to produce slabs in ideal condition for rapid and economical processing is easily solved by Askania Control Systems. • Once the desired conditions have been established, the operator may "set and forget" the controls . . . Askania carries on . . . repeats with unfailing accuracy and precision the exact cycle, time after time.

JET PIPE PRINCIPLE

ASKANIA REGULATOR CO.
1603 S. MICHIGAN AVENUE, CHICAGO

THE WAPAKONETA MACHINE CO.
Incorporated 1891 — Wapakoneta, Ohio.

N·B·M BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings • Roll Neck Bearings • Housing Nuts • Machinery Castings • Acid Resisting Castings • Phosphorized Copper • Locomotive and Car Journal Bearings • Babbitt Metals

NATIONAL BEARING METALS CORP.
ST. LOUIS • PITTSBURGH • NEW YORK

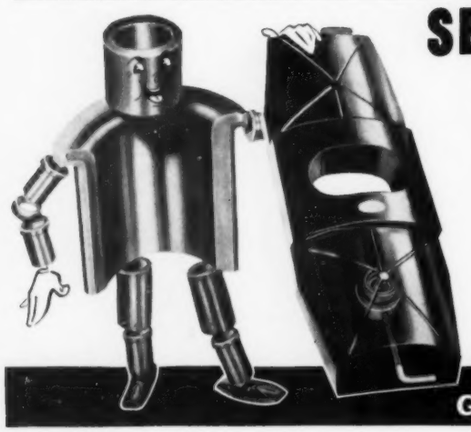
J. M. Darbaker has been appointed as assistant manager of Chicago district operations of Carnegie-Illinois Steel Corporation, United States Steel Corporation subsidiary. **Charles A. Ferguson,** assistant general superintendent of the Gary sheet and tin mill since

J. M. DARBAKER

December, 1938 is promoted to general superintendent, succeeding Mr. Darbaker.

In his new position Mr. Darbaker succeeds R. G. Glass, who recently became vice president and general manager of U. S. Steel Corporation's new subsidiary, Geneva Steel Company at Provo, Utah. Mr. Darbaker's promotion follows nine years as general superintendent of the Gary sheet and tin mill.

Mr. Darbaker began his career with the U. S. Steel Corporation Subsidiaries upon his graduation in July, 1920 from the University of Michigan with a degree in mechanical engineering. He served as assistant master mechanic in the Vandergrift, Pennsylvania works of American Sheet and Tin Plate Company. He served successively as resident engineer of the company's Wellsville, Ohio works, and master mechanic at the Shenango, Pennsylvania works. In September, 1932 he became master mechanic at the Gary sheet and tin mill and served in this capacity until August, 1933 when he became assistant to manager. He was advanced to



SELF-ALYN SLIPPER BEARINGS

The GATKE Invention that Revolutionized Universal Coupling Performance . . .

- 10 times longer service.
- Eliminate Socket Scoring and Wear.
- *Avoid costly machine shop work.*
- End destructive vibration.
- Stop pounding noises.
- Prevent Grease slinging.
- Made to fit without machining for all sizes and types of UNIVERSAL COUPLINGS.
- Information on request.

Gatke MOULDED FABRIC Bearings

GATKE CORPORATION - 228 N. La Salle - CHICAGO

manager of the combined sheet and tin mill in October, 1934 and continued in this capacity until July, 1936 when the company was merged with the Carnegie-Illinois Steel Corporation and he became general superintendent of the combined operations.

CHARLES A. FERGUSON

Mr. Ferguson first became associated with the U. S. Steel Corporation subsidiaries in February, 1913 when he served as assistant master mechanic at the Vandergrift works and later became assistant manager of Farrell works and manager of Farrell-Mercer works of the American Sheet and Tin Plate Company. In December, 1938 he was made assistant general superintendent of Carnegie-Illinois Steel Corporation's Gary sheet and tin mill, which position he has held until the present time. He also is a University of Michigan graduate with a mechanical engineering degree.

H. G. COFFEY

H. G. Coffey formerly manager of sales of the Aetna-Standard Engineering Company, Youngstown, Ohio, has been elected vice president in charge of sales and production.

Mr. Coffey has previously served as manager and assistant manager of sales for this company. He joined

UNCLE SAM SAYS:

Save Fuel Oil

DACAROL will help you to comply with the recent request of the United States Government to conserve fuels.

EVERY USER OF FUEL OIL HAS EXPERIENCED:

— clogged oil lines, preheaters, strainer, burner tips, etc.
— loss of oil through sludge formation in tanks.
— the evil effects of sludge in the oil system.

DACAROL fuel oil treatment will eliminate these undesirable conditions. It dissolves deposits. It prevents future formation of deposits.

TRY IT IN YOUR OWN PLANT —
THEN JUDGE FOR YOURSELF

DAKAROL P. H. Solvent saves time and labor, dissolves sludge, gum and carbon deposits in pre-heaters and coils.

DACAR PRODUCTS

DACAR CHEMICAL PRODUCTS COMPANY

Wabash and McCartney Streets Pittsburgh, Pa.

Noisy Gears are *Weary* Gears

Noisy gears are wasting power. Worse yet, metal to metal contact causes tooth wear that results in steadily decreasing efficiency and eventual expense for replacement.

Tooth wear is prevented by NON-FLUID OIL which keeps metal coated with a tough, adhesive film through which gear teeth cannot "bite." Unaffected by pressure or temperature (high or low) NON-FLUID OIL reduces cost by lasting longer than other lubricants.

Used successfully in leading iron and steel mills. Send for instructive bulletins.

•

New York & New Jersey Lubricant Co.

Main Office: 292 Madison Ave., New York 17, N. Y.

WAREHOUSES:

Chicago, Ill. — Atlanta, Ga.
St. Louis, Mo. — Detroit, Mich.
Providence, R. I. — Charlotte, N. C. — Greenville, S. C.

TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT OFFICE & FOREIGN COUNTRIES

Modern Steel Mill Lubricant

Better Lubrication at Less Cost per Month

the Aetna Foundry and Machine Company, the predecessor of the Aetna-Standard Engineering Company, in a sales capacity about 18 years ago, after service with the Youngstown Sheet and Tube Company.

E. O. Austermiller has been appointed assistant chief engineer of the National Tube Company at McKeesport, Pennsylvania.

He was formerly with Day and Zimmerman, Inc., of Philadelphia, Pennsylvania, and Chicago, Illinois, as mechanical and electrical engineer. Prior to his connection with Day and Zimmermann he was with the H. A. Brassert Company of Pittsburgh, Pennsylvania, the Wisconsin Steel Works in S. Chicago, Illinois and the La Belle Iron Works of Steubenville, Ohio.

L. F. McGlincy has been appointed assistant manager of operations, Pittsburgh district of American Steel and Wire Company, subsidiary of U. S. Steel Corporation. **Loren J. Westhaver** has been named general superintendent of the Donora (Pennsylvania) Steel and Wire Works succeeding Mr. McGlincy.

Mr. McGlincy was born in Worcester, Massachusetts and attended elementary and high school in that city before matriculating at Worcester Polytechnic Institute, from which he was graduated with a B.S. degree in metallurgical engineering. His first employment with American Steel and Wire Company was in September, 1924, as a rate setter at South Works in Worcester. He held various positions in that plant and was superintendent of the open-hearth and rolling mill before being transferred to Cleveland as division metallurgist in

Specialists for over a generation in

OIL IMMERSED MOTOR CONTROL

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

charge of billet and rod-rolling in March, 1939. He has been general superintendent of Donora Steel and Wire Works since February, 1941.

Mr. Westhaver was born and educated in Melrose, Massachusetts. He was graduated from Dartmouth College before becoming associated with American Steel and Wire Company as a tester in the rope mill at South Works, Worcester, in November, 1928. He progressed through the ranks until in December, 1939, he was appointed superintendent of the Steel Works at South Works. In June, 1942, he was transferred to Donora as assistant general superintendent of the Steel and Wire Works, which post he has held to the present time.

Obituaries

Edward Salter Stickle, born December, 1884, died October 25 at his home in Pittsburgh, Pennsylvania. He was born and educated in Rochester, New York.

After working a few years with the Stromberg-Carlson Telephone Company in Rochester, in 1909 Mr. Stickle came to Pittsburgh and became associated with Western Electric as a telephone specialist.

EDWARD SALTER STICKLE

In 1918 he organized his own company, the E. S. Stickle Company, Pittsburgh representatives for manufacturers of electrical equipment, of which he was the head at the time of his death.

He was a member of the Association of Iron and Steel Engineers and the Engineers Society of Western Pennsylvania.

John D. Crawbuck, pioneer in the electrical equipment field and head of John D. Crawbuck Company, Pittsburgh, Pennsylvania, died recently after a nine-day illness from pneumonia. A native of New York City, Mr. Crawbuck started his business career in 1902 with Rossiter-MacGovern Company, later transferred to Wicks Brothers and still later to Miller-Owen Electric Company, Pittsburgh, where he was president until 1926, when he started the firm which bears his name. Mr. Crawbuck is survived by his son Walter, who is associated in the business and will continue it under the policies established by his father. Mr. Crawbuck was one of the leaders in the used electrical equipment field and played an important part in its development.

AND SAVE MACHINING, LUBRICANT AND POWER

You're doing right by your roll necks when you lubricate them with Dixon's Roll Neck Graphited Grease. It's made expressly to lengthen the life of necks and brasses by preventing premature wear and scoring. You favor your costs, too, with Dixon's because it saves lubricant, maintenance labor and machining time. Cuts power bills by keeping necks free-running. Especially valuable for mills with plain bearings. Write department RN-50 for proof.

NEW *Know-How Packages* FOR DIXON'S GRAPHITES

Use pictures, instructions and a 7-page booklet on the container show how and where to use graphite profitably.

Available now in 5-pound Ticonderoga No. 1 (Large Flakes), Ticonderoga No. 2 (Medium Powdered Flakes), No. 635 (Finely Powdered Flakes) and Microfyne (Extra Finely Powdered Flakes). Other sizes in the previous long-used containers, at your suppliers.

JOSEPH DIXON CRUCIBLE COMPANY, JERSEY CITY 3, N. J.

Canada: Canadian Asbestos Company • Montreal • Toronto • Vancouver • Winnipeg

Graphite Pipe Joint Compound • Lathe Center Lubricant • Graphited Oils

Cup and Pressure Gun Grease • Waterproof Graphited Greases

Gear Lubricants • Belt Dressing (Contains no Graphite)

WELLMAN *Industrial* FURNACES

An Installation of Wellman side-door Ingot Furnaces. Each furnace has two chambers; normal charge each chamber is 18, 12″ x 12″ x 50″ ingots (often increased 50 to 100%). Operating temperatures up to 2400° F., using oil or washed anthracite producer gas. Served by 2,000 lb. Wellman Ingot Charging and Withdrawing Manipulator.

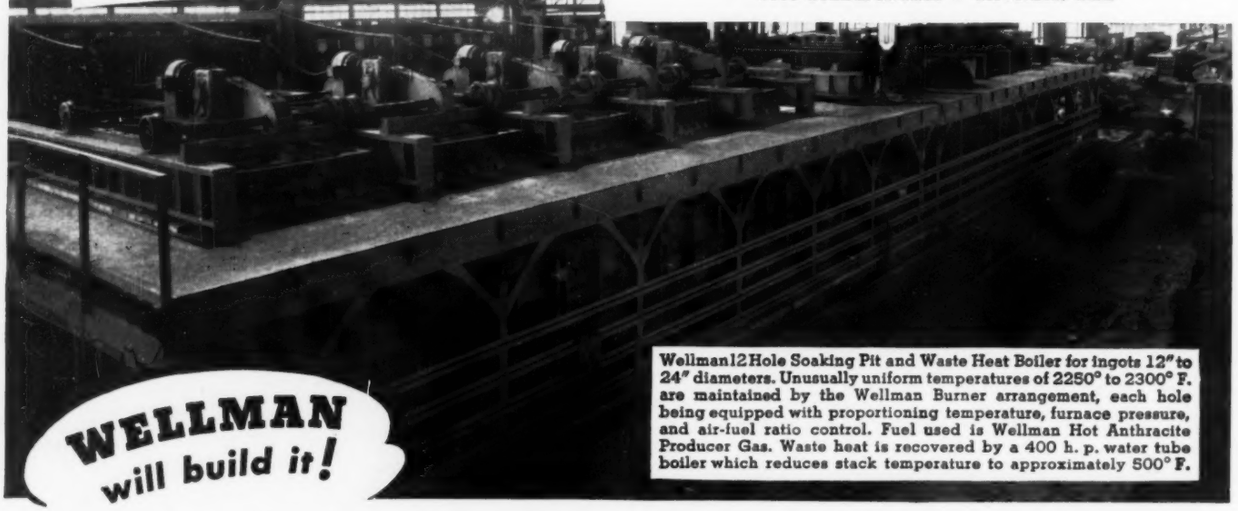
Two Wellman Furnace installations for annealing, normalizing, low temperature annealing, hardening and drawing high carbon steel bars and gun barrels. Furnace dimensions, 22′ wide x 20′ effective length. Installation includes rotary quenching mechanism, chargers, ejectors, run-out tables, and oxy-acetylene cut-off machine. A Wellman gas plant supplies washed anthracite gas to produce operating temperatures from 900° F. to 1850° F.

for INGOTS, BILLETS, SLABS, BARS, RODS—*and GUN BARRELS!**

Wellman Furnaces represent the last word in design, control, automatic operation, and installation. Our Furnace department is headed by engineers who are thoroughly experienced in the specialized field of heat-treating (continuous and reheating), normalizing, and annealing. We can assume responsibility for the design, manufacture, and erection of complete installation, including gas generating plants, ovens, and furnaces, and material handling equipment.

******If you have a problem of converting your heat treating furnaces from regular service to high speed war production, perhaps we can help you. Write*

THE WELLMAN ENGINEERING COMPANY
7009 Central Avenue • Cleveland, Ohio



WELLMAN will build it!

Wellman 12 Hole Soaking Pit and Waste Heat Boiler for ingots 12″ to 24″ diameters. Unusually uniform temperatures of 2250° to 2300° F. are maintained by the Wellman Burner arrangement, each hole being equipped with proportioning temperature, furnace pressure, and air-fuel ratio control. Fuel used is Wellman Hot Anthracite Producer Gas. Waste heat is recovered by a 400 h. p. water tube boiler which reduces stack temperature to approximately 500° F.

Ore Unloaders • Ore and Coal Bridges • Skip and Mine Hoists • Clamshell Buckets • Coke Oven Machinery
Car Dumpers • Charging Machines • Cranes • Industrial Furnaces • Soaking Pits • Gas Plants • Reversing Valves

INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Company 1
Air Reduction Sales Company 26
Alliance Machine Company 105
Allis-Chalmers Manufacturing Company 22
American Hammered Piston Ring Division, Koppers Company 24
American Hoist and Derrick Company 136
American Institute of Bolt, Nut and Rivet Manufacturers 8, 9
Askania Regulator Company 137
Automatic Transportation Company 23

B

Bantam Bearings Division, The Torrington Company 96
Bartlett Hayward Division, Koppers Company 24
Birdsboro Steel Foundry Machine Company 111
Bloom Engineering Company 114
Bonnot Company 10
Broden Construction Company 14

C

Clark Controller Company 127
Cleveland Crane and Engineering Company 4
Cleveland Worm and Gear Company 11
Continental Roll and Steel Foundry Company 13
Crouse-Hinds Company 132
Cutler-Hammer, Inc. ..... Cover 2

D

Dacar Chemical Products Company 139
De Laval Steam Turbine Company 74, 92
Joseph Dixon Crucible Company 141

E

Edison Storage Battery Division, Thomas A. Edison, Inc. 130
Electric Controller and Manufacturing Company 12
Electric Service Supplies Company 30
Electric Storage Battery Company 109
Engineering and Construction Division, Koppers Company 24

F

Farrell-Birmingham Company, Inc. 115
Farval Corporation 94
Flinn and Dreffein Company 14

G

Gas and Coke Division, Koppers Company 24
Gatke Corporation 138
General Electric Company ..... Cover 4

H

Hagan Corporation 108
Hallden Machine Company 14
Hays Corporation 128
Heppenstall Company 119
E. F. Houghton and Company 95
Hyatt Bearings Division, General Motors Corporation 85
Hydropress, Inc. 3

I

I-T-E Circuit Breaker Company ..... Cover 3

K

C. M. Kemp Manufacturing Company 121
Koppers Coal Company 24
Koppers Company 24
Koppers-Rheolaveur Company 24

L

Leeds and Northrup Company 16
Lewis Foundry and Machine Division, Blaw-Knox Company 2
Linde Air Products Company 17, 18, 19, 20
Loftus Engineering Corporation 136

M

Mackintosh-Hemphill Company 101
Maryland Drydock Company 24
Mathews Conveyer Company 32
Jas. H. Matthews Company 67
McKay Machine Company 14
Merco-Nordstrom Valve Company 131
Mesta Machine Company 27
Morgan Construction Company 90
Morgan Engineering Company 135

N

National Bearing Metals Corporation 138
National Carbon Company, Inc., Carbon Sales Division 97
National Roll and Foundry Company 106
New York and New Jersey Lubricant Company 140
Norma-Hoffmann Bearings Corporation 144
North American Manufacturing Company 29

O

Ohio Electric Manufacturing Company 106
Okonite Company 21

P

Pennsylvania Transformer Company 104
Philco Corporation, Storage Battery Division 117
Phillips Mine and Mill Supply Company 118
Pittsburgh Lectromelt Furnace Corporation 36
Pittsburgh Rolls Division, Blaw-Knox Company 28
Poole Foundry and Machine Company 120
Post-Glover Electric Company 110

R

Reliance Electric and Engineering Company 123
E. D. Richardson and Sons Manufacturing Company 137
Rockbestos Products Corporation 125
Rollway Bearing Company, Inc. 107
Rowan Controller Company 139, 140

S

Schloemann Engineering Corporation 103
SKF Industries, Inc. 31
Socony-Vacuum Oil Company, Inc. 25
Speer Carbon Company 112
Surface Combustion 6, 7

T

Tar and Chemical Division, Koppers Company 24
Tate-Jones and Company, Inc. 133
Thomas Flexible Coupling Company 122
Timken Roller Bearing Company ..... Cover 1
The Torrington Company, Bantam Bearings Division 96
Tool Steel Gear and Pinion Company 86, 87
Truflo Fan Company 102

U

Union Carbide and Carbon Corporation 17, 18, 19, 20, 97
Union Steel Casting Division, Blaw-Knox Company 91
United Engineering and Foundry Company 34, 35

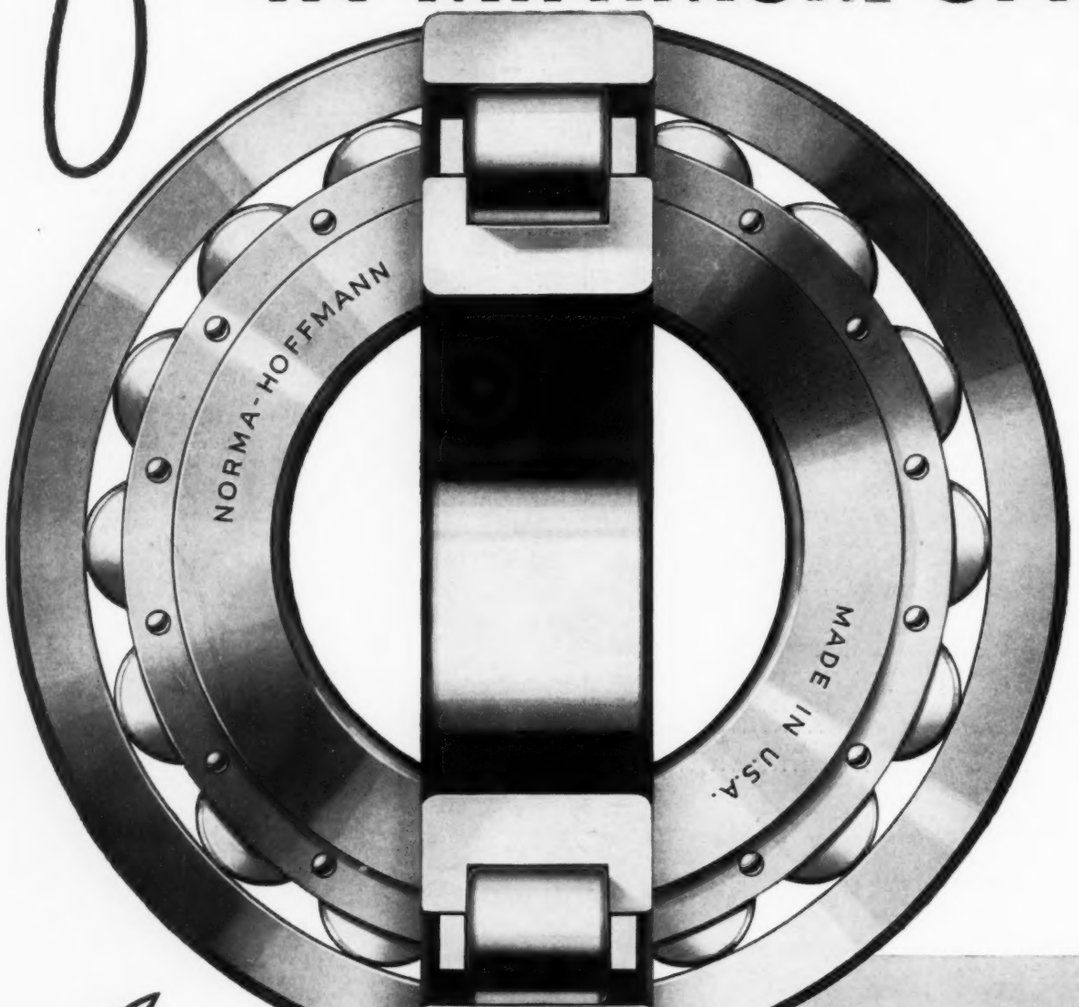
W

Wagner Electric Corporation 113
Wapakoneta Machine Company 138
Wean Engineering Company 14
Wean Engineering Company of Canada, Ltd. 14
Wellman Engineering Company 142
Wellman Smith Owens Corporation, Ltd. 14
Western Gas Division, Koppers Company 24
The White Tar Company of New Jersey, Inc. 24
The Wood Preserving Corporation 24
Worthington Pump and Machinery Corporation 126

Y

Youngstown Alloy Casting Company 15

for MAXIMUM CAPACITY IN MINIMUM SPACE



Interchangeable

WITH SINGLE-ROW BALL BEARINGS

NORMA-HOFFMANN

PRECISION ROLLER BEARINGS

NORMA-HOFFMANN BEARINGS CORP'N.,

STAMFORD, CONN., U. S. A. • *Founded in 1911.*

Write for the Catalog. Let our engineers work with you.

Their solid cylindrical rollers provide maximum contact area, giving larger load and shock-absorbing capacity than any other single-row bearing of like dimensions. Thus, when NORMA-HOFFMANN PRECISION ROLLER BEARINGS are used in place of ball bearings, a greater factor of safety is provided, together with added life, particularly under vibration and overload. PRECISION qualities in workmanship and materials adapt them alike for both low and high speeds.

TO WIN THE WAR — WORK — FIGHT — BUY WAR BONDS

ALL for STEEL MILLS...

ALL by I-T-E

For electrical protection, steel mill engineers have a wide choice of I-T-E equipment. Switchgear with its circuit breakers, disconnects and protective devices is built by I-T-E with the characteristics needed for any steel-mill installation.

MT CIRCUIT BREAKERS

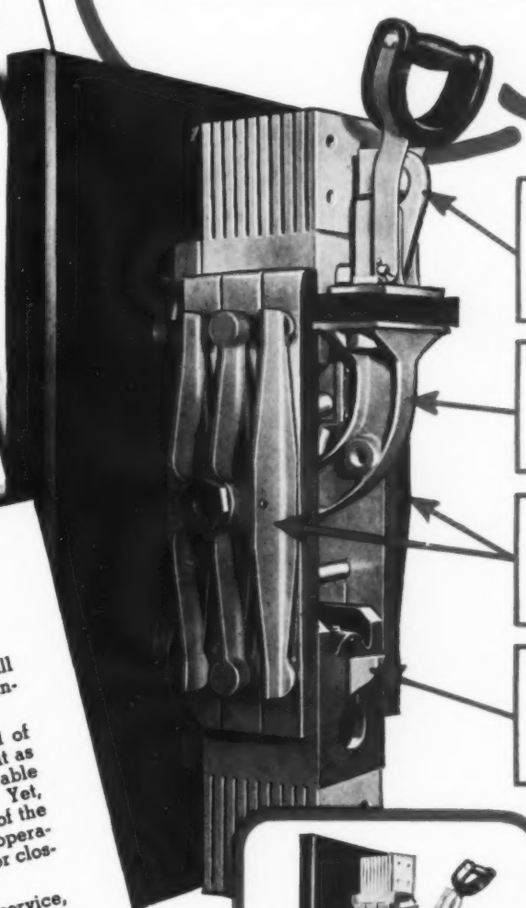
SWITCHGEAR

KB CIRCUIT BREAKERS

KC CIRCUIT BREAKERS

AUTOMATIC RECLOSING CIRCUIT BREAKERS

FB CIRCUIT BREAKERS



HANDLE LATCH assures the switch will remain completely closed in a location where severe vibration may be expected, by preventing the handle and operating arm from creeping open.

OPERATING ARM rotates about its pivot and first releases the pressure on the clamping bars, then engages the blades and moves them to the fully open position of the switch.

CLAMP BARS press blades tightly against contact blocks, assuring high pressure contacts when switch is closed. Release of pressure makes switch easy to operate. All contact surfaces are silver plated.

STOP PLATE with shock-absorbing spring supports blade assembly in open position. Another stop plate at upper end prevents blades blowing open by engaging handle latch when switch is closed.

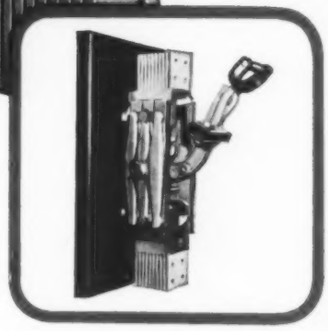
KLAMP-TITE SWITCHES

Steel mills need reliable switches—ones that will hold fast, will carry current with negligible loss for long periods free from maintenance and will open when necessary with safety and ease.

Klamp-Tite, in all its standard and special forms, is that kind of steel-mill switch. It stays closed, as in the large view, as tight as a bolted bus joint. Clamping bars force the silver-plated movable blades against the terminals with heavy, constant pressure. Yet, one swing of the handle releases the pressure (as in the left of the smaller views) and opens the switch (as at the right). The operator's hand is safely clear of live parts in the entire opening or closing action.

Klamp-Tites are made in 1, 2 or 3 pole units, for 600-volt service, a-c or d-c, 1600 to 12,000 amperes, or for 23,000-volt service, 2000 to 5000 amperes. Handle, switch hook or remote operation can be provided.

Catalog 2702 describes Klamp-Tite switches in detail. We will send you a copy, or I-T-E engineers will galdly discuss Klamp-Tites with you—or any other I-T-E equipment made for steel-mill service.



I-T-E

AIR SWITCHGEAR

IMMERSED IN AIR • ENCASED IN STEEL

Representatives in Principal Cities

CIRCUIT BREAKER CO., PHILADELPHIA 30, PA.

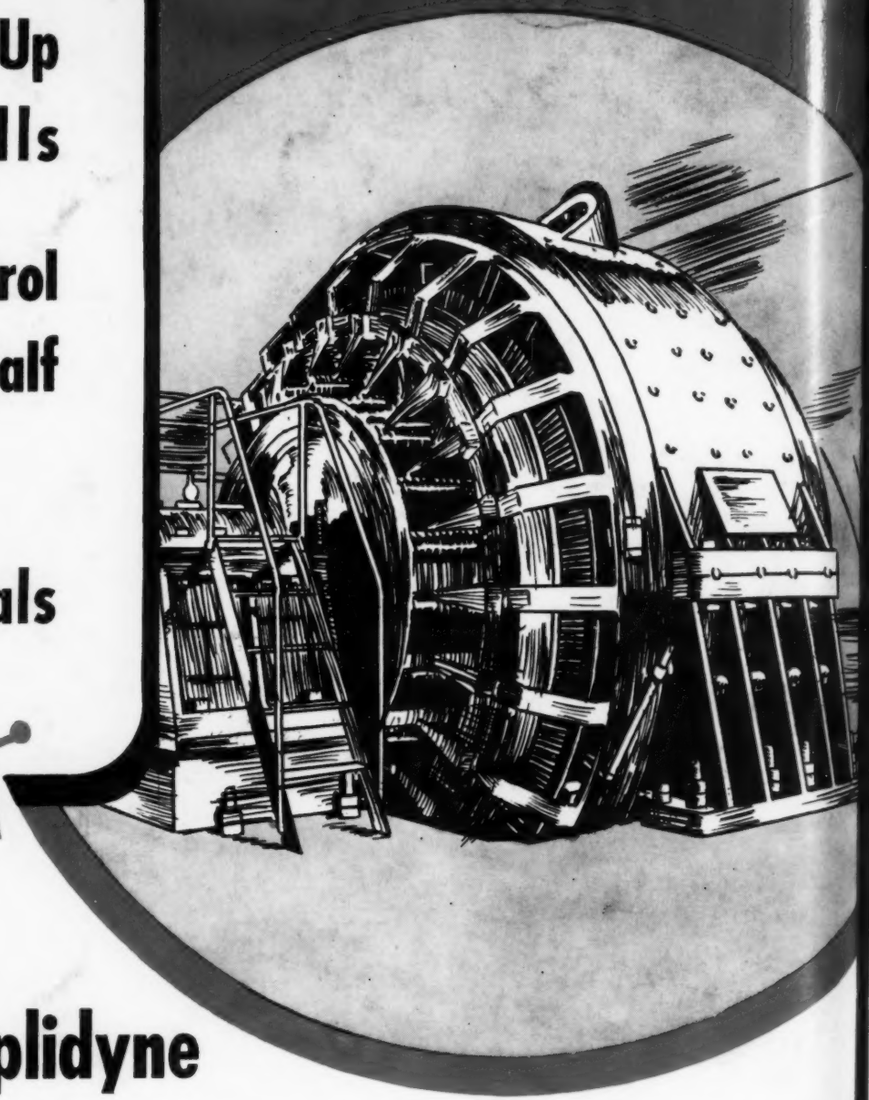
You Can Speed Up Reversing Mills

★

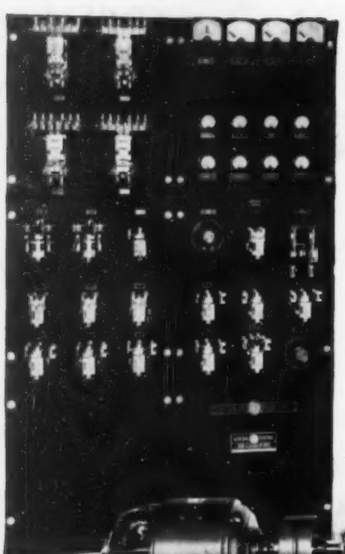
Cut Needed Control Devices by One Half

★

and Save Critical Materials



with the G-E Amplidyne



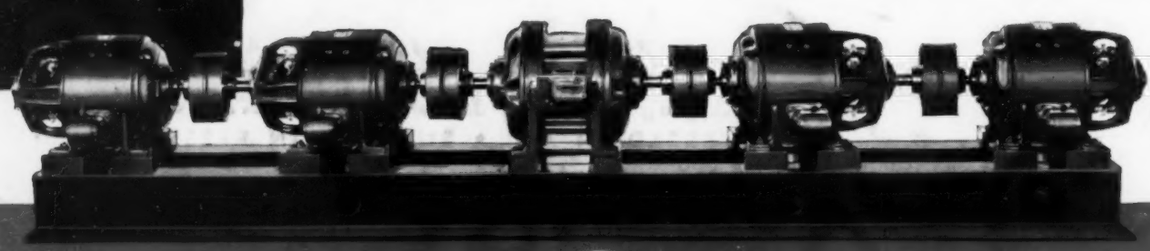
THE motor-amplidyne-generator set, which General Electric has applied to reversing-mill drives, permits the replacement of contactors—handling ***hundreds*** of amperes each—with relays handling a ***fraction*** of an ampere. This revolutionary change means not only longer life and less maintenance of the control devices—because relays are inherently easier to maintain than contactors handling heavy currents—it means also a ***50 per cent*** reduction in the number of control devices needed. Such a reduction saves maintenance time, ***skilled man-hours,*** as well as critical materials.

Speeds Up Output

The motor-amplidyne-generator provides accurate control of acceleration and deceleration of the mill, which is one assurance of maximum production. Effective load-limit control provides for maximum output of the motor. Improved voltage results from the use of the amplidyne—with resultant higher average speeds, and thus improved mill output. When twin drives are used, the amplidyne provides accurate load, torque, and speed balance between the drives.

If you would like more information about G-E amplidyne machines and their applications, see our local representative.

General Electric, Schenectady, N. Y.



G-E motor-amplidyne-generator set for control of reversing-mill drive. Relay panel at left.

GENERAL ELECTRIC

659-28-149